An Evaluation of Research in the United States on

(3)

HUMAN NUTRITION

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A Survey of Research on Human Nutrition Supported and/or Conducted by Public Research Organizations

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A Survey of Research on Human Nutrition Supported and/or Conducted by Public Research Organizations

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SUMMARY

Based on a survey of research projects maintained in the USDA's Current Research Information System and in the Smithsonian Institution's Science Information Exchange, 959 research projects conducted during 1968-69 were directly related to the subject of human nutrition (HN). Approximately $30 million were allocated to HN research during the year with 90 percent of the funds being supplied by various Federal Government agencies. On the other hand, 64 percent of these funds were expended on HN research performed by universities.

The primary goal of 51 percent of the HN research projects was the prevention and amelioration of specific physiological abnormalities through improved nutrition. This compares with 17 percent allocated to HN research directly concerned with normal physical and mental development and maintenance, 7 percent on research aimed at improving nutrition-related food practices, and 25 percent on HN research of broad application.

Over 78 percent of HN research funds were allocated to activities primarily concerned with determining the nutrient requirements in humans (over half to studies of body metabolism and functioning); 8 percent to research on determining the nutrient composition of foodstuffs; 10 percent to research on behavioral factors related to food consumption; and 4 percent to the study of nutrition education and public programs aimed at implementing food knowledge.

Only one-third of HN research funds were allocated to projects which would provide knowledge applicable to individuals of particular age-sex groups of the population.

Only 36 percent of HN research funds are allocated to projects using humans as biological models. Annual expenditures on projects using humans average $37,300 compared with $27,000 for those using laboratory animals and $31,600 for all projects.

The single most important source of HN research funds was the HEW which provided over $17 million of the $27 million originating from Federal Government agencies. HEW support was primarily directed to those projects concerned with correcting physiological problems. The support funds from the USDA were devoted to the study of normal nutrition needs and the prevention of the development of health problems.

CONTENTS

A SURVEY OF RESEARCH ON HUMAN NUTRITION SUPPORTED AND/OR CONDUCTED BY PUBLIC RESEARCH ORGANIZATIONS

INTRODUCTION

The survey of nutrition research was intended to identify the types and scope of research in progress at the time of the survey which is aimed at generating new knowledge about the various facets of human nutrition problems. The purpose for undertaking such an inventory was to provide a foundation for evaluating the current state of human nutrition research as a basis for planning the future direction of research. One companion report defines the current status of nutrition-related health problems and a second assesses the current state of knowledge about human nutrition.

Scope of Survey

The basic interest of this survey was in research on the nutritional requirements of humans and the foods consumed by them. Many factors affect human nutrition, including factors traditionally included in the areas of food production and marketing, pharmacology, and disease. Therefore, it was necessary to delineate the problems to be considered from those which would be better handled under other research evaluation studies.

As a general guide, research was included in the survey if the subject of study pertained to events that occurred during or after the selection of food at the grocery store or from a menu in restaurants. Studies involving commercial and institutional food preparation and service were included because of the close similarities of the subject matter studied. In particular, areas of interest included factors affecting the selection of foods, the nutritive value of foods consumed, the utilization of food by the body, and the nutrition education and Government programs which contribute to attaining good nutrition.

The survey excluded projects which dealt primarily with the diagnosis and medical treatment of disease except those which involved dietary regimes relevant to normal human nutrition. The survey also excluded research involving domestic animals which was primarily intended to improve animal production or solve a particular physiological problem, even though the findings of such research might have direct implications to human nutrition.

The survey included human nutrition research that was sponsored and/or conducted by public or semi-public (foundations, etc.) organizations, departments, or agencies. Research conducted by private firms was excluded unless sponsored by a public agency.

Survey Procedures

The sources of information on research projects were the Current Research Information System (CRIS), maintained by the U.S. Department of Agriculture, for projects conducted or sponsored by the USDA and the State agricultural experiment stations and the Scientific Information Exchange (SIE), maintained by the Smithsonian Institution, for projects not included in CRIS. In both cases, research project statements were retrieved by selected key words. Project statements that were duplications or were about topics of extraneous interest to the survey were subsequently evaluated and sorted out by visual inspection.

Based on extensive discussions among members of the study committee regarding the kinds of information desired from the survey and the content of the project statements, appropriate coding instructions and format were developed. These are included in Appendix A. A number of USDA and State specialists in areas related to human nutrition coded the information contained in the project statements based on their subjective interpretations of the information presented. As expected, in some cases quite arbitrary decisions had to be made regarding the coding of certain information having alternative interpretations; however, information categories were defined as specifically as possible to reduce the need for such arbitrary decisions.

Two precautions should be given. First, while it is believed that the survey includes substantially all human nutrition research studies, based on spot checking by research scientists for known studies, no guarantee of completeness is possible. Further, the considerable amount of human judgment embedded in the results of this survey should be emphasized. Nevertheless, the survey does provide significantly more information on the status of human nutrition research than has heretofore been available.

Classification of Human Nutrition Research

The manner in which information from research projects has been classified for tabulation and reporting is tied directly to the analytical structure developed for the subsequent evaluation of research needs. The development of the analytical procedures is described in a subsequent report; that part relating to the classification of information is briefly described here. In addition, Appendexes A and B of this report explain the interpretations of the categories which were used in the classification process.

An initial step in the analysis was the development of a classification scheme to permit the logical manipulation of information relevant to the study area. The classification scheme, as the analytical structure itself, reflects how the information will be used. In this study, three areas of information were considered to be of primary interest: (1) Policy goals--the conditions or states of our society or subgroups desired by policy makers. (2) Nutritionally-oriented health and food problems--the impediments or unfavorable conditions which deter achievement of the desired nutritionally related conditions implied by the policy goals. (3) Research programs--the corrective actions to be carried out by both technical and social scientists to ameliorate the indicated problems. The further sub-division of these three categories, which are largely independent, should be most meaningful to those who are primarily concerned with each area, namely: administrators for the first, research scientists for the third, and to both for at least some elements of the second. Fundamentally, the classification scheme is concerned with the order of information within each of these areas while the analysis is concerned with the relationship among the areas.

The policy goals, which were not included in the coding of the survey information, primarily relate to the length of human life and to its quality as indicated by effects on individual productivity and well-being. In the survey, these goals were reflected in the research goals of the projects by the types of nutrition-related problems studied.

The classification of related scientific knowledge reflects how scientists perceive the human nutrition area. Four different classifications were included: (1) Type of research activity--determining (a) human nutritional requirements, (b) nutrient composition of food, (c) behavioral factors related to consumption, or (d) public programs related to improving the nutritional state of individuals. (2) Type of nutrient--the five basic classes of nutrients plus energy. (3) Target groups--subgroups of the population which seem to be characterized by particular types of nutrition problems. (4) Biological model--the nature of the research subject, indicating how research is performed.

Three other classifications of general interest were included: (1) the type of agency providing the support funds for the research, (2) the type of agency or institution performing the research, and (3) the geographical location of the performing organization.

PRINCIPAL FINDINGS OF SURVEY

Total Expenditures on Human Nutrition Research

There were 959 separate research projects being conducted or sponsored by public or semi-public organizations during 1968-69 which had objectives directly related to some facet of human nutrition. These 959 projects

accounted for an estimated annual expenditure of nearly $30 million. The largest share of the human nutrition research funds, 64 percent, was allocated to universities. Over 90 percent of this research was supported by various agencies of the Federal Government, principally from the U.S. Department of Health, Education, and Welfare (Table 1).

When numbers of projects rather than amount of support funds are compared, the share of research conducted by universities, at 73 percent of the 959 projects, was even greater. The lower level of annual support for university research projects may simply reflect the longer period of years over which projects are normally conducted in the university. This may result from scientist commitments to teaching as well as research, rather than any real differences in total project support.

Table 1. Distribution of Research Funds by Type of Agency Performing Research and by Type of Agency Supporting Research

Type of Agency	Percent of Research Funds	
	Performing Research	Supporting Research
Federal Government Agencies	19.0	91.5
State Government Agencies	.8	5.2
Foundations	6.2	2.8
Industry and Other	1.2	.4
Universities	63.9	.1
Hospitals	8.8	.0
TOTAL	100.0	100.0

Another factor may explain the lower expenditures on human nutrition research projects in the universities. In many project statements, the only source of funds indicated was a specific grant. This was particularly true for HEW-supported projects. However, such a grant seldom covers the full cost of a research project. As an example, one State requires by law that the university partly support all research conducted in that university. In this case, contract administrators estimated that State funds or funds from local foundations and trusts support about 10 percent of the cost of Federally-supported projects. To the extent that this is typical, total expenditures on human nutrition research by universities could be understated by about $1.5 to $2.5 million, and the contribution of State governments for research support by a comparable amount.

Goals of Nutrition Research

The objectives of research projects are usually stated in terms of the knowledge intended to be generated by the research and seldom indicate the

policy goals to which this knowledge will eventually contribute. In this survey judgments were made regarding the primary goal to which the research was implicitly, if not explicitly, intended. The distribution of research by these goals, which relate to several aspects of individual health and personal satisfaction, is given in Appendix Table 1.

By far the greatest number of human nutrition research projects had a primary goal dealing with the prevention and amelioration of specific physiological abnormalities.1/ While 51 percent of both research funds and numbers of projects were allocated to research in this area, only 17 percent of the funds were allocated to research with goals primarily concerned with normal physical and mental development and maintenance. However, it is emphasized that the distinction between normal and physiological function is somewhat artificial since these represent only degrees of interpretation rather than distinct definable states.

About 25 percent of all research funds were allocated to research projects of broad applications. Predominant among these were research on fundamental or basic concepts in human nutrition which are required by scientists in order to seek solutions to the more specific types of nutrition problems. Only 7 percent of all human nutrition research funds were allocated to research on the application of nutrition knowledge. This includes such things as improving the skills of homemakers in the selection and preparation of foods and implementing various programs to facilitate the dissemination of nutrition-related knowledge.

Program Areas of Research Activities

Improving the nutritional status of individuals requires adequate knowledge about several associated factors. First, knowledge is required on the nutritional requirements of individuals and on certain related physiological characteristics. In addition, knowledge must be obtained on what foods provide these required nutrients. Further, knowledge is required about what constitutes desirable patterns of food consumption and related behavior if the nutritional status of individuals is to be improved. Finally, knowledge is required about means of bringing about improvements in the nutritional status of individuals by means largely outside the control of the individual.

1/ A discussion of specific human nutrition problems, especially of physiological problems, as research goals is not intended to imply that the research is necessarily designed to solve these types of existing problems. Rather, in many cases it is known and in others it is strongly believed that certain nutritional characteristics are conducive to or, if not corrected, will eventually lead to the specific types of nutrition problems indicated. Hence, the statement of nutrition problems as research goals is intended for the most part as a point of reference for various unfavorable nutritional tendencies.

As shown in Table 2, studies of various facets of nutrient requirements of humans accounted for $23.8 million, or almost 80 percent of all human nutrition research funds. By far the largest proportion of this expenditure ($13.5 million) was concerned with the metabolism and function of nutrients. Only 17 percent of funds was allocated to research aimed primarily at nutritional requirements rather than how nutrients are utilized. In contrast, less than 11 percent of all human nutrition research funds was allocated to determining the existing nutritional status of individuals.

Table 2. Expenditures on Human Nutrition Research by Types of Research Activities and Subcategories

Types of Research Activities and Subcategories	Total Expenditures	Percent of Total
	thousand dollars	
Nutrient Requirements	23,798	78.5
Digestion and Absorption	1,665	5.5
Metabolism and Function	13,498	44.5
Nutrient Requirements	5,317	17.5
Nutritional Status	3,290	10.8
Unclassified	31	0.1
Nutrient Composition	2,339	7.7
Consumption	2,894	9.5
Expenditures	154	0.5
Practices	666	2.2
Dietary	2,074	6.5
Implementation	1,285	4.2
Education	803	2.6
Non-education	482	1.6
TOTAL	30,316	100.0

Research on the nutrient composition of food accounts for 8 percent of allocated funds. Research on behavior related to the acquisition and consumption of food amounted to only $2.5 million, or less than 9 percent of all human nutrition research funds; over two-thirds was allocated to investigation of dietary patterns and related factors; less than a third was allocated to investigations of the various practices, primarily of homemakers, associated with acquiring, handling, storing, and

preparing meals; and, a very small amount of research effort was devoted to investigating actual patterns of expenditures of food, or factors affecting expenditures, either for consumption within or outside the home. Only about $1.3 million, or less than 5 percent of all funds, were allocated to research on programs and activities concerned with the implementation of nutrition knowledge; nearly two-thirds were expended on research intended to improve human nutrition through education; and, about a third on investigating nutrition-related programs, such as food stamps, school lunch, etc.

Beneficiaries of Nutrition Research

As indicated by Table 3, nearly two-thirds of human nutrition research funds were allocated to projects that provide results having general applicability to all individuals rather than to specific subgroups of the population (target groups). Two notable exceptions were investigations of reproductive and infant mortality problems which were intended to benefit primarily children less than 6 years of age (including "premies") and about growth problems which benefit primarily the age group 7-12 years of age. But even in the latter case, there was $1.0 million of research which was intended to produce generally applicable results.

Matching the allocations of funds to projects according to specific target groups benefited with that according to the primary type of nutrition-related problem investigated (Appendix Table 18) indicates some relationships that have rather broad implications. For example, funding for research on heart problems increased from the younger to the older age groups. While the highest incidence of heart problems occurs at the older ages, preventive actions involving nutrition are most likely to be fruitful at an earlier age. Also, there was a large concentration of funds on research related to reproductive problems intending to benefit primarily children under 6 years of age but none to pregnant and lactating mothers. At the same time more funds were allocated to the study of diabetes in pregnant and lactating mothers than to all other target groups combined. A number of other such comparisons also deserve attention.

Table 3. Expenditures on Human Nutrition Research by Target Groups

Target Group	Total Funds	Percent Allocation
	thousand dollars	
Nonspecific[a]	19,013	62.7
7-12 Years	2,404	7.9
36-60 Years	1,788	5.9
Over 60 Years	1,516	5.0
Under 1 Year	1,468	4.8
1-6 Years	1,390	4.6
13-19 Years	740	2.4
20-35 Years	596	2.0
Infirm	684	2.3
Pregnant and Lactating Women	548	1.8
All Female[b]	110	.4
All Male[b]	59	.2
TOTAL	30,316	100.0

[a]Research results would be generally applicable to all individuals.

[b]Age group received precedence over sex in this Table; that is, if a research project listed the target group as "all female 13-19 years," then the funds are shown under "13-19 years." Such cases were not numerous.

Nutrient Requirements and Composition

The basic building blocks of technical investigations into human nutrition are the nutrients themselves. In this survey nutrients were grouped into classes as shown in Table 4 in order to facilitate coding and tabulation. In all, $23.2 million were allocated to projects which directly or indirectly included the study of one or more of these nutrients and/or the energy value of diets. Studies about some aspect of protein, minerals, or fats received the largest share of these funds, although substantial amounts were also allocated to the study of vitamins. The lesser amounts allocated to the study of energy may simply indicate that the primary focus of research was included under carbohydrates and fats.

Table 4. Expenditures on Human Nutrition Research by Types of Nutrients and by Types of Research Activities

Nutrient Categories	Requirements[a]	Composition[a]	Total	Percent Allocation
		thousand dollars		
Protein	4,258	813	5,071	21.8
Minerals	3,936	520	4,456	19.2
Fat	4,144	303	4,447	19.1
Vitamins	3,006	175	3,180	13.7
Carbohydrate	1,583	105	1,689	7.3
Energy[b]	490	3	493	2.1
Unspecified[c]	3,584	303	3,887	16.7
TOTAL	21,002	2,221	23,223	100.0

[a]Amounts for Nutrient Categories will not total to Type of Activity totals because the method of coding the data reflected the fact that the study of nutrients as such was not always the primary aim of a study.

[b]"Energy" was listed as a separate nutrient category to indicate energy considerations having no particular relevance to a specific nutrient.

[c]"Unspecified" was used to indicate a general interest in nutrition without special relevance to specific nutrients.

The study of specific nutrients seemed to have varying importance to different nutrition-related problems (Appendix Table 16). However, the study of only one type of nutrient was seldom considered exclusively important to a particular nutrition-related problem. The most striking relationship was the nearly $3 million allocated to the study of fats in heart disease. Other notable relationships were the study of mineral and/or vitamin effects on anemia, protein and/or mineral effects on growth generally, carbohydrates on diabetes, and energy values on obesity.

As indicated by Table 5, studies of nutrients are predominantly concerned with the physiological characteristics associated with nutrient requirements of humans as opposed to the study of nutrient composition of foods. Further, for all types of nutrients, the primary interest in human utilization of nutrients has to do with the study of the metabolic functions of nutrients. Determining specific nutrient requirements was a distant second in research emphasis.

Table 5. Total Dollars Research Support by Type of Nutrients and by Requirement Type of Research Activity Subcategories

Nutrients	Requirements Subcategories					Total
	Digestion-Absorption	Metabolism-Function	Nutrients Required	Nutrition Status	Unclassified	
	thousands dollars					
Protein	275	1995	1657	331	0	4258
Minerals	478	1623	746	1076	13	3936
Fats	267	2922	812	231	12	4144
Vitamins	131	2042	616	217	0	3006
Carbohydrate	263	947	319	55	0	1583
Energy	37	173	151	130	0	490
Unspecified	95	1728	827	934	0	3584
TOTAL	1446	11430	5127	2973	25	21002

Research Methods

In this survey, it was assumed that the biological model used in research efforts--the subject or object which the scientist directly studies or experiments with, even though the results are intended for ultimate application to humans--was indicative of how research is conducted in human nutrition. As shown in Table 6, animals (usually rats) and humans (as individual subjects) were by far the most frequently used biological models, together accounting for nearly three-fourths of all research funds. Although total funding was comparable, animal biomodels were used in far more projects than were human biomodels, reflecting the substantially higher cost of the use of humans in research programs.

Human and/or animal biomodels were most frequently utilized in nearly all projects regardless of research goals; the one principal exception was for research relating to the application of food knowledge in which population groups was the predominant research vehicle (Appendix Table 20). Other types of biomodels were largely utilized in research involving physiological aspects of nutrition problems and on research with goals having general applicability for improving human nutrition. From the standpoint of the program areas of research activities, human and animal biomodels are again the predominant research vehicle for projects studying human requirements; food composition studies utilize primarily animal; and both consumption and implementation studies rely primarily on human and population biomodels.

Table 6. Expenditures on Human Nutrition Research by Type of Biological Model Used in Research

Biological Model	Total Funds	Percent of Total	Average Size of Allocation
	thousand dollars		thousand dollars
Animal	11,291	37.2	27
Human	10,976	36.2	37 (35)[a]
Population	2,998	9.9	37 (32)[a]
Subcellular and Cell-free Biochemistry	1,602	5.3	32
Tissues and Cells	1,130	3.7	26
Microorganisms	574	1.9	41
Unclassified	1,745	5.8	30
TOTAL	30,316	100.0	32

[a]Numbers in parenthesis are average allocations excluding the two very large OEO projects.

Geographical Distribution of Research

As shown in Table 7, there were conspicuous locational differences in fund allocations. For example, fund allocations to research on human nutrition performed in the Northeast Region were about double the amounts allocated to each of the next two regions ranked by level of support. On the other hand, its relative allocation of total research funds was about the same as its relative share of total population--a tendency which did not generally hold over all regions. Also as indicated in Table 7, the regions receiving the highest level of total support also had the highest average level of support per project.

Table 7. Distribution of Research Projects and Funds by Geographical Region in Which Research Was Conducted.

Region	Total Dollars	Percent of Total	Number of Projects	Average Dollars
	thousand dollars			
Northeast	7,997	26.4	217	36,800[a]
Eastern	4,756	15.7	122	39,600
Western	4,025	13.3	134	30,000
North Central	3,525	11.6	78	45,200[a]
East Central	2,759	9.1	114	24,200
Central	2,302	7.6	85	27,100
Southeastern	1,615	5.3	79	20,400
Southwestern	1,361	4.5	46	29,600
Foreign	1,065	3.5	46	23,200
Mountain	911	3.0	38	24,000
TOTAL	30,316	100.0	959	31,600

[a]The Northeast would be $35,100 and the North Central $36,400 excluding the two OEO projects allocated to these regions.

Among the four regions which received the largest allocations of research funds, emphasis varied relative to types of problems studied, according to intended research goals. Although the physiological emphasis, which includes research aimed at nutrition in heart disease as well as other abnormalities, received the most funds in all regions, there were still some substantial variation in the relative spheres.

Regions differed only slightly in the proportion of funds allocated according to program areas of research activities. In all regions, studies on nutrient requirements received the largest share of research funds. Relatively more funds were directed to nutrient composition studies in the East, Central, and Western Regions and relatively more to consumption studies in the Northeast, North Central and East Central, and Eastern Regions (Appendix Table 52).

There were some differences in the biological model used in nutrition studies among regions (Appendix Table 62). The Northeast, North Central, and Western Regions and Foreign allocated by far the most funds to research using human biomodels, while the Southeast and Mountain Regions utilized primarily animal biomodels. Only the Central Region allocated more funds to a biological model other than human or animal, namely subcellular and cell-free biochemistry.

Table 8. Percentage Distribution of Research Funds Among Four Regions by Research Goals.

Research Goals	Region				
	Northeast	East	North Central	Western	Total
Physiological	52.8	37.7	50.5	63.8	50.7
Productivity and Well-being	17.6	12.7	26.9	5.5	17.0
Food Knowledge Application	6.5	17.3	1.5	4.0	7.6
Unclassified	23.1	32.3	21.2	26.7	24.7
TOTAL	100.0	100.0	100.0	100.0	100.0

Agencies Supporting Research

As previously shown (Table 1), over 91 percent of all human nutrition research funds came from Federal Government agencies. However, there were substantial differences among agencies in both the amount of funds provided and numbers of projects supported (Table 9). State governments and foundations were the only other significant sources of research funds.

For most of the supporting agencies, the university was the primary recipient of research funds, receiving nearly two-thirds of all research funds. Only the USDA, the DOD, and the VA allocated more funds to Federal Government research organizations than to universities. In comparison, the HEW, with the largest total allocation of funds, allocated 5 percent of those funds to Federal research labs, while NASA allocated approximately 17 percent and NSF, AEC, and OEC allocated no funds to Federal labs.

While some differences could be identified in both the absolute and relative levels of support by type of supporting agency among geographical regions, it is questionable how significant these differences were. Research on human problems isn't so locationally oriented as, for example, research on crops. In all regions, Federal agencies supplied more funds for human nutrition research that non-Federal sources. However, except for the Southeast, North Central and Central Regions, a substantial amount of the Federal funds go to support the research activities of laboratories located in each region. State support in the Western, East Central, and Northeast Regions did contribute significantly more to human nutrition research than in other regions, but only in the Western and East Central Regions was this amount relatively significant.

Table 9. Distribution of Research Projects and Funds and Average Funds Per Project by Type of Agency Supporting Research.

Type of Agency	Total Funds Allocated	Numbers of Projects[a]	Average Funds per Project[b]
	thousand dollars		thousand dollars
U.S. Government Agencies	27,743	851	33
HEW	17,528	517	33
USDA	3,715	183	20
DOD	2,789	72	38
VA	1,800	45	40
OEO	1,143	2	571
NSF	361	19	18
AEC	89	4	22
NASA	72	7	10
Other	246	8	30
State Governments	1,580	186	8
Foundations	837	72	11
Industry	68	2	34
University	20	1	20
Others	68	9	7
TOTAL	30,316	959	32

a
Some double accounting is reflected in the numbers of projects because some projects received support from more than one source.

b
These are not average research project expenditures but average allocations to each project supported.

Based on relative allocations of research funds there were few meaningful differences among types of supporting agencies in the classes of nutrition-related problems each emphasized. For most supporting agencies, physiological problems received the major share of funds, substantially so in the case of HEW. However, even in the latter case, nearly $5 million was allocated to the unclassified category of nutrition problems and $2 million to productivity and well-being problems. In addition, other agencies also generally emphasized one or the other of these two classes of problems, such as the $1.1 million allocated to growth problems research by the OEO. Finally, while food knowledge applications was not the least supported class of problems by half of the agencies, only the USDA provided substantial support.

There also were some differences in the types of program areas of research activities supported by the various agencies (Appendix Table 50). All agencies emphasized research on nutrient requirements of humans. But whereas HEW allocated 86 percent of its $17.5 million to this type, USDA allocated only 54 percent of its $3.0 million for this purpose. The USDA exceeded HEW both absolutely and relatively in the amounts of funds allocated to composition studies, with the DOD and the States also allocating significant funds to this area. The HEW allocated the most funds to both consumption and implementation studies, but relatively less than USDA, DOD, VA, and OEO.

In addition to the obvious differences in total allocations of funds to human nutrition research, the considerable variation in average support per project shown in Table 9 also strongly suggests substantial differences in allocation policy among granting agencies. For example, HEW supports research by direct grants, whereas the USDA often supports research in universities jointly with State funds, based on a formula established by Congress.

It is readily apparent from Table 10 that single-source funded projects predominate in human nutrition. The 808 projects that were supported by only one source accounted for 88 percent of all funds. The primary exception was the joint role of USDA and State government in experiment station projects.

Table 10. Differences in Numbers of Sources of Research Funds Among Projects by Type Agency Supporting Research

Type of Agency	Single Source		Multiple Sources	
	Number	Average Dollars	Number	Average Dollars
		thousand dollars		thousand dollars
USDA	65	41	118	9
HEW	469	34	48	25
NSF	15	18	4	20
AEC	4	22	0	0
DOD	72	38	0	0
NASA	5	10	2	10
VA	45	40	0	0
OEO	2	571	0	0
Other Federal	2	55	6	22
State Governments	44	9	142	8
Universities	1	20	0	0
Foundations	72	11	0	0
Hospitals	0	0	0	0
Industry	2	34	0	0
Other	9	7	0	0
TOTAL	808	33	151	24

Agencies Performing Research

The dominance of universities in human nutrition research, both in total dollars expenditures and in numbers of research projects, is indicated by Table 11. The table also shows that there are considerable differences in the average size of research project among the types of research performers. While there might be some cost advantages in universities conducting research, the principal source of the lower average annual expenditure on the projects is simply the lower scale and longer period of time over which projects are conducted. The data did not suggest that the projects conducted by universities were more simple or less involved than those conducted by other types of research performers. The average expenditures for each type of research performer fairly represents the size of most of the projects; the average expenditures in Table 11 did not result from a few very large or very small projects.

Table 11. Distribution of Human Nutrition Research Projects and Funds by Type Agency Performing Research.

Performing Agency	Total Expenditures (1000 dollars)	Number of Projects	Average Expenditure (1000 dollars)
Universities	19,380	697	27
Federal Agencies	5,765	117	49
Hospitals	2,665	77	34
Foundations	1,886	49	38
State Agencies	249	4	62
Industry	174	8	21
Other	197	7	28
TOTAL	30,316	959	32

As shown in Table 12, there are sizeable differences among agencies performing research in the relative emphasis on goals of research efforts. Universities and Federal agencies spent substantially more on problems relating to productivity and well-being than did other types of research agencies. A relatively minor amount, less than $1 million or 5.1 percent of total funds allocated, was allocated by universities to research related to improving food knowledge. All types of agencies heavily emphasized research on nutrient requirements of human types of studies, the universities somewhat more so than other types. Federal agencies and foundations emphasized studies on implementation more than other types of agencies. Hospitals stressed consumption studies in addition to requirements studies. The differences among types of research performers in biological models used are largely ones of degree, rather than any significant characteristic differences.

Table 12. Percentage Distribution of Research Funds among Classes of Nutrition Problems by Type of Agency Performing Research.

Type Research Agency	Class of Nutrition Problem				Total
	Physiological	Productivity and Well-Being	Food Knowledge Application	Unclassified	
University	52.2	15.4	5.1	27.3	100.0
Federal Agency	35.2	18.5	20.9	25.4	100.0
State Agency	48.2	51.8	0	0	100.0
Industry	71.3	28.7	0	0	100.0
Foundation	52.9	27.3	3.3	16.5	100.0
Hospital	74.2	9.2	1.5	15.1	100.0
Other	5.1	79.7	0	15.2	100.0
TOTAL	50.7	17.0	17.6	24.7	100.0

As research performers, only universities engaged in research that was funded from more than one source. Of these projects, the 142 were supported by the State governments, and 118 by the USDA, largely the same ones. HEW supported fewer multiply-funded projects but at a much higher level of support than either USDA or the State governments.

APPENDIX A

CODING FORM AND INSTRUCTIONS

HUMAN NUTRITION RESEARCH SURVEY
CODING FORM

(coded by_____)
initials

Information: complete_____
incomplete_____

1. Project Identification: [: : : : : : : : :]
1 5 10

2. Performer Agency: [: : : : :]
11 16

3. State:_____ [:]
17 18

4. Supporting Agency: [:]
19 20

5. Size of Effort: ($000) [: :]
21 23

6. Type Problem: [:]
24 25

7. Biological Model: [ ]
26

8. Requirement Type: [ ]
27

9. Type Activity: (Percent Distribution) [: : : : : : : : : :] = 100%
All Equal | Requirements | Composition | Consumption | Implementation
28 29 32 35 38 40

(Code 0-3) [: : :]
Expendi. Practices Consump.
41 42 43

[: :]
Education Institutions
44 45

10. Nutrients: (Code 0-3) [: : : : : : :]
All Equal | Carbohydrate | Fats | Proteins | Minerals | Vitamins | Energy
46 47 48 49 50 51 52

11. Target Groups: (Percent Distribution)

[: : : : : : : : : : : : : : :] = 100%
All Equal | Preg & Nurs Mothers | Infants 1 t 1 yr. | Infants 1-6 yrs. | Children 7-12 yrs. | Adolescents 13-19 yrs. | Adults 20-35 yrs. | Adults 36-60 yrs. | Adults 60+ yrs. | Infirm & Disabled
53 54 57 60 63 66 69 72 75 78 80

HUMAN NUTRITION RESEARCH
CODING INSTRUCTIONS

Inclusion/Exclusion of Research Projects: In many cases it is difficult to decide whether or not a project should be included in or excluded from the survey. There are no clear-cut rules to follow and judgments will need to be used extensively. In general, if the product of the research is to reveal new information relating to the nutritional requirements of humans, or nutrient composition of foods, or utilization thereof, then the project should be included. If it basically implies some new information about bodily functions or factors related to marketing or production, then it would be excluded. In any case, if there is a question of whether it should or should not be included, set the project aside for later consideration. Note that there is no advantage gained in including a project that should not be in the survey.

General Instructions: Initial each form coded in the upper right corner (for reference, if necessary). After a project has been coded, indicate by checking the appropriate line whether information requested is complete or incomplete. In case of incomplete information, place a check next to the missing information.

Item 1 - Project Identification: All numbers justified are to the right (blank spaces are to the left). On the CRIS listing use the CRIS Accession Number. On the SIE listing use SIE Accession Number. In both cases omit leading "0's," dashes, and parenthesis.

Item 2 - Performer Agency: The first space should indicate the type of performing agency as follows:

U - University
G - Federal Government Agency
S - State Government Agency
I - Industrial/Private Company
F - Foundation or Research Organization
H - Hospital
O - Other

The remaining spaces can be used for an abbreviation of the performing organization. For example, if the agency is Howard University, then the entry would be "UHOWAR."

Item 3 - State: Enter the abbreviation for the State in which research is conducted or research organization is located. Use 2-digit letter codes, conversion to numeral codes will be done by the computer.

States

Regions	1	2	3	4	5	6	7	8	9
1	ME	NH	VT	MA	CT	NY	PA	NJ	RI
2	MD	DE	DC	VA	WV	NC	SC		
3	TN	LA	MS	AL	GA	FL	PR	VI	
4	MI	OH	IN	IL	KY				
5	WI	MN	IA	ND	SD				
6	MO	NB	KA	OK	AR				
7	TX	NM	AZ						
8	MT	UT	ID	WY	CO	NV			
9	WA	OR	CA	AK	HI	GU			
0	All Foreign								

Item 4 - Supporting Agency: The first space should indicate the type of supporting agency providing the financial support for the research. Use the same code as in Item 2 above. The second digit is used only for "G" code, as follows:

0 - USDA, Regular appropriations
1 - USDA, Specials and grants
2 - HEW
3 - NSF
4 - AEC
5 - DOD
6 - NASA
7 - VA
8 - OEO
9 - Other

Item 5 - Size of Effort: This information is usually on the SIE forms but not on the CRIS forms. If not available, check Item 5 and the "incomplete information" line at the top, but finish completing Items 6-8. Dollars are in "thousands of dollars." Use 500-499 as the range for rounding.

Item 6 - Type of Problem: The classification of nutritionally oriented health problems must be subjectively determined by reviewing the statement of research. In each case indicate the predominant problem investigated. The computer will convert class designation.

Functional (101-119)

1. Heart and vasculatory complications, including stroke
2. Respiratory and digestive illness
3. Mental and emotional problems and stability
4. Infant mortality and reproductive problems
5. Early aging and shortened lifespan
6. Arthritis
7. Dental Health
8. Diabetes and carbohydrate disorders
9. Osteoporosis
10. Obesity
11. Anemia and other nutrient deficiency diseases
12. Alcoholism
13. Eye sight
14. Cosmetic (hair, skin)
15. Allergies
16. Kidney and urinary problems
17. Muscular dystrophy
18. Cancer
19. Tumors (non-cancerous)

Productivity and Well-being (201-203)

1. Improved work efficiency and leisure enjoyment
2. Improved learning ability
3. Improved growth and development

Food Selection and Handling (301-304)

1. Improved efficiency in food preparation and menu planning
2. Reduced losses of nutrients in food storage, handling, and preparation.
3. Improved efficiency in food selection
4. Improved efficiency in food programs

Other

1. Unclassified (400)

Item 7 - Biological Model: Indicate the nature of the research approach to the problem under investigation, determined by subjective review of the project statement.

1. Human
2. Animal
3. Tissues and cells
4. Microorganism (protozoa and bacteria)
5. Subcellular and cell-free biochemistry
6. Population studies (social groups)
7. Unclassified

Item 8 - Requirement Type: Nutrient requirement studies can be conducted with one of several orientations. Indicate the nature of the study orientation based on your subjective review of the project statement. If the study does not concern requirements, this cell will be left blank.

1. Digestion and absorption
2. Metabolism and function
3. Nutrient requirements
4. Nutritional status
5. Other
6. Unclassified

Item 9 - Type of Activity: These refer to areas of research activities included under nutrition, as follows:

Requirements - Specification of amounts and combinations of the various nutrients required by individuals.

Composition - Determination of nutrient content of foodstuffs and their availability.

Consumption - Areas concerned with behavioral aspects of human nutrition, including factors related to expenditures on food, home management practices, choice, habits, etc.

Implementation - Relates to research on extension activities or action programs concerned with motivating change or implementing the new knowledge generated.

For each project, distribute 100 points among the four categories according to your judgment of its relative emphasis. If the project has equal relevance, put a "1" under All Equal and leave the remaining spaces blank.

For the three categories under Consumption and two categories under Implementation indicate the degree of relevance to each of the specific topics, as follows:

Blank - No relevance
1 - Some relevance but not much
2 - Relevance but not the main focus
3 - - The Primary focus of the study

The categories should be interpreted as follows:

Expenditures - Subjects bearing on the amount spent on foodstuffs.

Practices - Subject relating to food handling and preparation.

Consumption - Subjects relating to food choice and habits and dietary considerations.

Education - Subjects concerned with motivation and extension types of activities.

Institutional - Subjects relating to factors largely outside of individual control usually requiring actions by some government agency.

Item 10 - Nutrients: If projects can be identified clearly as to their relevance to particular types of nutrients (primarily for "Requirements" and "Composition" in Item 9), then the degree of relevance should be indicated for each by the "0-3" code as described under Item 9. If specific relevance is not apparent, place a "1" under All Equal. If no relevance exists, place a "9" under All Equal. The category Energy relates to calorie considerations which essentially are directly concerned with carbohydrates, fats, or proteins.

Item 11 - Target Groups: The Target Groups imply a problematical relevance of the research product to certain segments of the population; that is, the solution of the problem to which the research is addressed is more critical to individuals in one or more groups than in others. The relative importance in this case does not refer to relative numbers but to relative intensity of the problem. The categories are considered mutually exclusive; that is, no one counted in one category would also be included in another. Again, the proportions assigned should add up to 100.

The All Equal category should be coded as follows:

Blank - Relative importance by categories is indicated.

1 - Problem is of equal importance to all groups.

2 - Relative importance by categories is indicated but is most significant to the male population.

3 - Relative importance by categories is indicated but is most significant to the female population.

APPENDIX B

STATISTICAL TABLES

TABLE NUMBERS BY INFORMATION CATEGORIES

INFORMATION CATEGORIES		PFMR	SUPT	REG	TP	TA	RQSB	CNSB	IMSB	NUTR	TGT	BM
Type of Agency Performing Research	(PFMR)				2 3	48 49		75 76				58 59
Type of Agency Supporting Research	(SUPT)	70,71 72		66 67	4 5	50 51		73 74			22 23	60 61
Geographical Region of Performing Agency	(REG)	64 65			6 7	52 53		68 69		38 39		62 63
Types of Nutrition-Related Problems	$(TP)_1$			8 9		10 11	12 13	14 15		16 17	18 19	20 21
Types of Research Activities	(TA)											
Requirements Subcategories	(RQSB)											
Consumption Subcategories	(CNSB)											
Implementation Subcategories	(IMSB)											
Types of Nutrients	(NUTR)					40 41	42 43					44 45
Types of Target Groups	(TGT)	24 25		26 27		28 29	30 31	32 33		34 35		36 37
Types of Biological Models	(BM)					46 47	54 55	56 57				

GENERAL COMMENTS ON TABLES

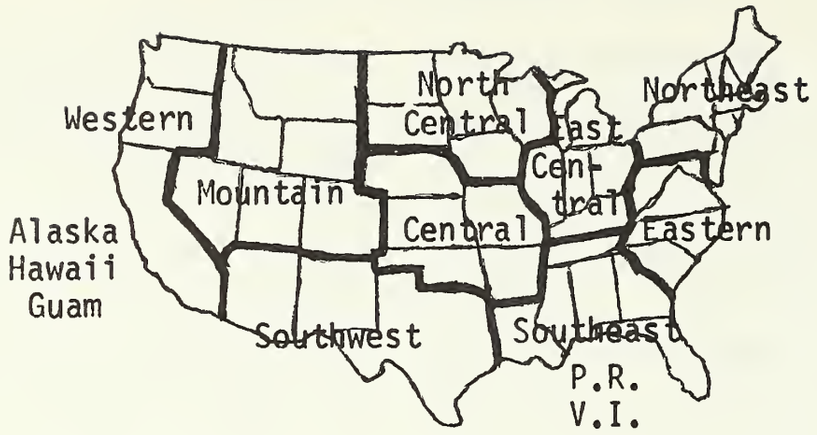
Funding Information: The dollars support was obtained from the respective project statements. These may or may not be the actual expenditures that occurred. Also, not all project statements had funding data provided. To supply estimates for these cases, a table comparable to Table 72 was generated for all projects with funding information. The average dollars support for appropriate "Supporting-Performing" Agencies pairs from this table was used to supply missing funding information in those project statements. In the two cases in which the table provided no average estimate, the figure used was an estimate provided by the responsible administrator of that agency. These two cases were $50,000 per project for Industrial Research Performers sponsored by DOD and $40,000 per project for all research sponsored by the VA.

Reported Dollars Support and Numbers of Projects: Except for Table 1 and Table 72, the tables are presented in pairs, the first reporting Dollars Support for indicated categories and the second reporting Numbers of Projects for the same categories. There is a difference in how numbers appearing in each category and the row and column Totals are to be interpreted between the Dollar and Number Tables in each pair. In all cases, the Total Dollar Support for a research project was allocated to the respective row and column categories according to procedures explained in the Footnotes for each table. Hence, the row and column Totals are simply the sum of all figures appearing in each row or column. In tallying Numbers of Projects, each project was not fractionalized when it pertained to more than one category, rather each category to which the project pertained was credited with "1" project. However, the total for each row and column in these tables reflects only once each project appearing in that row or column. Hence, in many cases, the row and column Totals in the Numbers Tables will not be the numerical sum of the respective rows and columns.

FOOTNOTES TO TABLES

(NOTE: Lettered (a) footnotes refer to explanations at the bottom of the table. Numbered (1) footnotes refer to explanations given in the following.)

[1]Regions: Regional specification refers to the location in which the research organizations performing the research are located. The regional grouping of states is given in the diagram below. The "Foreign" category includes all locations not shown in the diagram.



[2] Nutrition-Related Problems: The classification of nutritionally oriented health problems was subjectively determined by the scientists coding the project statements. In each case, only the predominant problem being investigated in the project was indicated. Where there was no clear relationship between the research objectives and procedures and one of the types of problems, the project was listed as "Unclassified."

[3] Class of Problem: See Table 1 for the specific types of nutrition-related problems included in each Class grouping.

[4] Biological Model: This refers to the general method used in conducting the research project and was subjectively determined by the scientists coding the project statements. Only the predominant method was indicated where readily evident; otherwise, the project was listed as "Unclassified." The methods were as follows:

1. Human
2. Animal
3. Tissues and cells
4. Microorganism (protozoa and bacteria)
5. Subcellular and cell-free biochemistry
6. Population studies (social groups)
7. Unclassified

[5] Type of Research Activity: This classification refers to the area or areas of activities related to resolving nutrition-related problems with which each research project is concerned, as follows:

Requirements - Specification of amounts and combinations of the various nutrients required by individuals.

Composition - Determination of nutrient content of foodstuffs, their availability, and the impact on general physiology (effect of gluten content on mental health).

Consumption - Areas concerned with behavioral aspects of human nutrition, including factors related to expenditures on food, home management practices, choice, habits, etc.

Implementation - Relates to research on extension activities or action programs concerned with motivating change or implementing the new knowledge resulting from research.

The scientists coding the project statements subjectively determined the relative emphasis of the research project among these four types of activities, according to the statement of objectives and procedures. For projects with reference to type of activity not clear, equal weight was given to the four. Total research funds were then proportionately allocated among these activities for each project.

[6] Target Groups: The Target Groups imply a problematical relevance of the research product to certain segments of the population; that is, the solution of the research problem will have more relevance to individuals in some groups than in others. By convention, these groups are primarily, but not exclusively, differentiated by age groups. In this survey, Pregnant and Nursing Mothers, Premature Babies (included in the Under 1 Year grouping), and the Infirm and Disabled (regardless of age) were important exceptions to the age grouping. Also, in many cases the research is more relevant to to "All Females," to "All Males," or to all females and males alike without regard to age group.

Again, the scientists coding the project statements subjectively determined the relative importance of the research topic to each Target Group. In this case, the relative importance does not refer to relative numbers in each grouping but to the relative intensity of the problem. Also, the groupings are considered mutually exclusive; that is, no one counted in one category would also be included in another (for example, Pregnant and Nursing Mothers and Age Group 20-35). In those cases in which coding indicated the research to be most relevant, say, to females in age group 20-35 as opposed to males in the same age group, the allocation was to the age group rather than to the "All Female" group. For each project, total research funds were then proportionately allocated among the Target Groups according to indicated relative importance.

[7]Nutrients: For those research projects relating to Requirements and Composition Types of Research Activities, the scientists subjectively determined from the project statements the relevance of the research effort to particular types of nutrients, namely: carbohydrates, fats, proteins, minerals, vitamins, and energy (not particularly relevant to specific nutrients), or to unspecified (all nutrients without any specific emphasis on any one or more). For a given project, each nutrient was coded as follows:

0 - No Relevance
1 - Some relevance, but not much
2 - Relevant, but not the main focus
3 - The primary focus to the project

The total research funds were arbitrarily allocated to each nutrient category as follows:

$$T_{n_i} = \frac{1}{3}\frac{1}{N} n_i (P_1 + P_2)$$

Where

T_{n_i} = the dollar allocation to nutrient category i = 1,...,7

N = the number of nutrients to which the project relates

n_i = the code (0-3) for nutrient "i"

P_1 = the proportion of total research funds allocated to the Requirement Research Activity

P_2 = the proportion of total research funds allocated to the Composition Research Activity

The division by 1/3 indicates that if only one nutrient is involved and it is coded "3," then all of the P_1 and/or P_2 will be allocated to it; or, if any nutrient is coded less than "3" (excluding "0's"), then the total amount in P_1 and/or P_2 cannot be allocated.

[8]Requirement Subcategories: Nutrient requirement studies can be conducted with one of several orientations. This classification indicates only the predominant type of approach taken in each research project and is based on subjective determination by the scientists coding the project statements. In each case, all of that proportion of total research funding allocated to the Requirement Type of Activity (see Footnote 5) was attributed to the predominant Requirement Subcategory indicated.

[9]Consumption Subcategories: For the Consumption Type of Activity, three areas of behavior were considered for each research project as follows:

Expenditures - Topics bearing on the amount spent and the selection of foodstuffs.

Practices - Topics relating to food handling and preparation.

Consumption - Topics relating to food choice and habits and dietary considerations.

For each case in which Consumption was indicated as a Type of Research Activity, scientists further determined the relevance of the research to one of the above topics. Each subcategory was coded 0-3, according to its relative importance, in the same manner as indicated in Footnote 7. The total research funds allocated to the Consumption Category was further allocated to the three subcategories proportionately to the indicated relative importance.

[10]Implementation Subcategories: For the Implementation Type of Activity, two general subclassifications of activity were considered for each research project, as follows:

Education - Topics concerned with food knowledge improvement, proper dietary motivation, and related extension types of activities.

Institutional - Topics relating to factors largely outside of individual control and usually requiring action by a non-private agency.

The allocation of research funds was entirely analogous to the procedures described in Footnote 9.

TABLE 1. TYPES OF NUTRITION-RELATED PROBLEMS--TOTAL DOLLARS RESEARCH SUPPORT, NUMBER OF RESEARCH PROJECTS, AND AVERAGE DOLLARS RESEARCH SUPPORT PER PROJECT

TYPE PROBLEM[2]	TOTAL RESEARCH SUPPORT	NUMBER OF RESEARCH PROJECTS	AVERAGE PROJECT SUPPORT
	(THOUSAND DOLLARS)		(THOUSAND DOLLARS)
PHYSIOLOGICAL			
HEART	5361	176	30
RESPIRATORY	37	2	18
MENTAL	911	33	27
REPRODUCTIVE	1213	43	28
EARLY AGING	1137	30	37
ARTHRITIS	205	7	29
DENTAL	582	19	30
DIABETES	1031	36	28
OSTEOPOROSIS	256	11	23
OBESITY	1395	35	39
ANEMIA	2045	70	29
ALCOHOLISM	391	9	43
EYE SIGHT	176	8	22
COSMETIC	68	4	17
ALLERGIES	18	1	18
URINARY	287	11	26
MUSCULAR	6	1	6
CANCER	159	6	26
OTHER TUMOR	96	3	32
PRODUCTIVITY AND WELL-BEING			
WORK-LEISURE	1312	35	37
LEARNING	231	11	21
GROWTH	3602	75	48
FOOD KNOWLEDGE APPLICATION			
MENU PLANNING	337	21	16
HANDLING	372	13	28
SELECTION	897	33	27
PROGRAMS	695	21	33
UNCLASSIFIED	7496	245	30
TOTAL	30316	959	32

TABLE 2. TOTAL DOLLARS RESEARCH SUPPORT BY CLASS OF NUTRITION-RELATED PROBLEMS AND BY TYPE OF AGENCY PERFORMING RESEARCH

TYPE AGENCY PERFORMING	CLASS OF PROBLEM[3]			
	PHYSIO-LOGICAL	PROD. AND WELL-BEING	FOOD KNOWLEDGE	UNCLASS
	(THOUSAND DOLLARS)			
UNIVERSITY	10114	2985	994	5287
FED AGENCY	2031	1065	1204	1465
STA AGENCY	120	129	0	0
INDUSTRY	124	50	0	0
FOUNDATION	997	514	63	312
HOSPITAL	1978	245	40	402
OTHER	10	157	0	30
TOTAL	15374	5145	2301	7496

TABLE 3. NUMBERS OF RESEARCH PROJECTS BY CLASS OF NUTRITION-RELATED PROBLEMS AND BY TYPE OF AGENCY PERFORMING RESEARCH

TYPE AGENCY PERFORMING	CLASS OF PROBLEM[3]			
	PHYSIO-LOGICAL	PROD. AND WELL-BEING	FOOD KNOWLEDGE	UNCLASS
UNIVERSITY	357	82	60	198
FED AGENCY	45	22	24	26
STA AGENCY	2	2	0	0
INDUSTRY	7	1	0	0
FOUNDATION	30	6	3	10
HOSPITAL	62	4	1	10
OTHER	2	4	0	1
TOTAL	505	121	88	245

TABLE 4. TOTAL DOLLARS RESEARCH SUPPORT BY CLASS OF NUTRITION-RELATED PROBLEMS AND BY TYPE OF AGENCY SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	CLASS OF PROBLEM[3] PHYSIOLOGICAL	PROD. AND WELL-BEING	FOOD KNOWLEDGE	UNCLASS
	(THOUSAND DOLLARS)			
USDA	924	414	1067	1310
HEW	10405	2143	193	4787
NSF	248	49	0	63
AEC	29	0	20	40
DOD	1002	1076	278	433
NASA	12	28	20	12
VA	1560	40	80	120
OEO	0	1143	0	0
OTHER FED	18	0	133	95
STATE GOV	600	140	292	548
UNIVERSITY	0	20	0	0
FOUNDATION	484	85	214	54
HOSPITAL	0	0	0	0
INDUSTRY	34	0	0	34
OTHER	58	7	4	0

TABLE 5. NUMBER OF RESEARCH PROJECTS BY CLASS OF NUTRITION-RELATED PROBLEMS AND BY TYPE OF AGENCY SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	CLASS OF PROBLEM[3]			
	PHYSIO-LOGICAL	PROD., AND WELL-BEING	FOOD KNOWLEDGE	UNCLASS
USDA	54	21	55	53
HEW	306	54	8	149
NSF	13	3	0	3
AEC	1	0	1	2
DOD	25	26	8	13
NASA	1	4	1	1
VA	39	1	2	3
OEO	0	2	0	0
OTHER FED	1	0	3	4
STATE GOV	61	20	41	64
UNIVERSITY	0	1	0	0
FOUNDATION	57	7	2	6
HOSPITAL	0	0	0	0
INDUSTRY	1	0	0	1
OTHER	7	1	1	0

TABLE 6. TOTAL DOLLARS RESEARCH SUPPORT BY CLASS OF NUTRITION-RELATED PROBLEMS AND BY REGION

REGION[1]	CLASS OF PROBLEM[3]			
	PHYSIO-LOGICAL	PROD. AND WELL-BEING	FOOD KNOWLEDGE	UNCLASS
	(THOUSAND DOLLARS)			
NORTHEAST	4225	1404	519	1849
EASTERN	1794	604	821	1537
SOUTHEAST	632	427	155	401
E.CENTRAL	1386	437	165	771
N.CENTRAL	1779	948	52	746
CENTRAL	1413	99	123	667
SOUTHWEST	878	310	32	141
MOUNTAIN	312	270	101	228
WESTERN	2568	220	163	1074
FOREIGN	387	426	170	82

TABLE 7. NUMBER OF RESEARCH PROJECTS BY CLASS OF NUTRITION-RELATED PROBLEMS AND BY REGION

REGION[1]	CLASS OF PROBLEM[3]			
	PHYSIO-LOGICAL	PROD. AND WELL-BEING	FOOD KNOWLEDGE	UNCLASS
NORTHEAST	123	27	14	53
EASTERN	53	17	20	32
SOUTHEAST	31	16	10	22
E.CENTRAL	63	10	11	30
N.CENTRAL	43	8	5	22
CENTRAL	45	4	12	24
SOUTHWEST	26	8	3	9
MOUNTAIN	15	9	4	10
WESTERN	86	7	6	35
FOREIGN	20	15	3	8

TABLE 8. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY REGION

TYPE PROBLEM[2]	REGION[1] NE	E	SE	EC	NC	C	SW	M	W	F	TOTAL
	(THOUSAND DOLLARS)										
PHYSIOLOGICAL											
HEART	754	425	230	584	1364	454	519	132	806	93	5361
RESPIRATORY	0	0	0	0	0	0	0	0	37	0	37
MENTAL	296	117	0	58	46	92	0	7	175	120	911
REPRODUCTIVE	493	104	21	134	25	50	145	0	170	71	1213
EARLY AGING	403	247	68	149	26	113	0	90	41	0	1137
ARTHRITIS	80	51	0	0	11	25	0	0	38	0	205
DENTAL	145	181	5	139	0	0	0	0	112	0	582
DIABETES	233	60	107	134	62	171	57	30	177	0	1031
OSTEOPOROSIS	56	64	0	0	0	25	0	0	111	0	256
OBESITY	799	173	14	66	0	53	0	0	280	10	1395
ANEMIA	556	210	167	0	167	299	67	53	460	66	2045
ALCOHOLISM	194	32	0	19	51	90	0	0	5	0	391
EYE SIGHT	77	9	20	0	12	0	0	0	58	0	176
COSMETIC	27	0	0	0	0	18	0	0	23	0	68
ALLERGIES	18	0	0	0	0	0	0	0	0	0	18
URINARY	82	40	0	23	15	0	50	0	50	27	287
MUSCULAR	6	0	0	0	0	0	0	0	0	0	6
CANCER	6	81	0	0	0	7	40	0	25	0	159
OTHER TUMOR	0	0	0	80	0	16	0	0	0	0	96

TABLE 8. CONTINUED

TYPE PROBLEM[2]	REGION[1] NE	E	SE	EC	NC	C	SW	M	W	F	TOTAL
	(THOUSAND DOLLARS)										
PRODUCTIVITY AND WELL-BEING											
WORK-LEISURE	226	170	70	140	11	50	310	160	109	66	1312
LEARNING	114	68	0	0	7	22	0	0	18	2	231
GROWTH	1064	366	357	297	930	27	t	110	93	358	3602
FOOD KNOWLEDGE APPLICATION											
MENU PLANNING	58	34	49	77	32	27	10	50	0	0	337
HANDLING	85	45	0	40	0	37	0	30	1	134	372
SELECTION	122	499	52	32	20	28	22	21	97	4	897
PROGRAMS	254	243	54	16	0	31	0	0	65	32	695
UNCLASSIFIED	1849	1537	401	771	746	667	141	228	1074	82	7496
TOTAL	7997	4756	1615	2759	3525	2302	1361	911	4025	1065	30316

[t]Less than $500.

TABLE 9. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY REGION

TYPE PROBLEM[2]	REGION[1] NE	E	SE	EC	NC	C	SW	M	W	F	TOTAL
PHYSIOLOGICAL											
HEART	31	10	13	26	24	14	14	8	28	8	176
RESPIRATORY	0	0	0	0	0	0	0	0	2	0	2
MENTAL	10	4	0	5	1	5	0	1	4	3	33
REPRODUCTIVE	12	4	1	6	3	2	6	0	6	3	43
EARLY AGING	7	8	3	3	2	3	0	2	2	0	30
ARTHRITIS	1	3	0	0	1	1	0	0	1	0	7
DENTAL	3	5	1	6	0	0	0	0	4	0	19
DIABETES	10	2	3	6	3	3	2	1	6	0	36
OSTEOPOROSIS	4	2	0	0	0	1	0	0	4	0	11
OBESITY	15	3	1	5	0	2	0	0	8	1	35
ANEMIA	19	6	8	0	6	8	2	3	14	4	70
ALCOHOLISM	2	1	0	1	1	3	0	0	1	0	9
EYE SIGHT	3	1	1	0	1	0	0	0	2	0	8
COSMETIC	1	0	0	0	0	1	0	0	2	0	4
ALLERGIES	1	0	0	0	0	0	0	0	0	0	1
URINARY	2	2	0	3	1	0	1	0	1	1	11
MUSCULAR	1	0	0	0	0	0	0	0	0	0	1
CANCER	1	2	0	0	0	1	1	0	1	0	6
OTHER TUMOR	0	0	0	2	0	1	0	0	0	0	3

TABLE 9. CONTINUED

TYPE PROBLEM[2]	REGION[1] NE	E	SE	EC	NC	C	SW	M	W	F	TOTAL
PRODUCTIVITY AND WELL-BEING											
WORK-LEISURE	6	4	3	3	1	2	7	4	3	2	35
LEARNING	4	3	0	0	1	1	0	0	1	1	11
GROWTH	17	10	13	7	6	1	1	5	3	12	75
FOOD KNOWLEDGE APPLICATION											
MENU PLANNING	3	2	4	4	2	4	1	1	0	0	21
HANDLING	3	2	0	2	0	3	0	1	1	1	13
SELECTION	5	8	2	3	3	3	2	2	4	1	33
PROGRAMS	3	8	4	2	0	2	0	0	1	1	21
UNCLASSIFIED	53	32	22	30	22	24	9	10	35	8	245
TOTAL	217	122	79	114	78	85	46	38	134	46	959

TABLE 10. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TYPE OF RESEARCH ACTIVITY

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY[5] REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION	TOTAL
	(THOUSAND DOLLARS)				
PHYSIOLOGICAL					
HEART	4763	162	429	7	5361
RESPIRATORY	37	0	0	0	37
MENTAL	854	20	14	23	911
REPRODUCTIVE	1150	0	58	5	1213
EARLY AGING	1008	56	73	0	1137
ARTHRITIS	205	0	0	0	205
DENTAL	535	27	20	0	582
DIABETES	880	8	5	138	1031
OSTEOPOROSIS	256	0	0	0	256
OBESITY	1020	0	355	20	1395
ANEMIA	1889	110	46	0	2045
ALCOHOLISM	391	0	0	0	391
EYE SIGHT	136	6	23	11	176
COSMETIC	68	0	0	0	68
ALLERGIES	18	0	0	0	18
URINARY	287	0	0	0	287
MUSCULAR	6	0	0	0	6
CANCER	159	0	0	0	159
OTHER TUMOR	56	0	0	40	96

TABLE 10. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TYPE OF RESEARCH ACTIVITY

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY[5]				TOTAL
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION	
	(THOUSAND DOLLARS)				
PRODUCTIVITY AND WELL-BEING					
WORK-LEISURE	1133	25	15	139	1312
LEARNING	203	t	14	14	231
GROWTH	2652	107	423	420	3602
FOOD KNOWLEDGE APPLICATION					
MENU PLANNING	31	123	171	12	337
HANDLING	25	159	176	12	372
SELECTION	66	134	574	123	897
PROGRAMS	129	170	152	244	695
UNCLASSIFIED	5841	1232	346	77	7496
TOTAL	23798	2339	2894	1285	30316

[t]Less than $500.

TABLE 11. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TYPE OF RESEARCH ACTIVITY

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY[5] REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION	TOTAL
PHYSIOLOGICAL					
HEART	171	13	12	2	176
RESPIRATORY	2	0	0	0	2
MENTAL	33	1	2	1	33
REPRODUCTIVE	43	0	4	1	43
EARLY AGING	29	2	3	0	30
ARTHRITIS	7	0	0	0	7
DENTAL	18	2	1	0	19
DIABETES	34	1	1	2	36
OSTEOPOROSIS	11	0	0	0	11
OBESITY	30	0	7	1	35
ANEMIA	69	7	4	0	70
ALCOHOLISM	9	0	0	0	9
EYE SIGHT	8	2	2	2	8
COSMETIC	4	0	0	0	4
ALLERGIES	1	0	0	0	1
URINARY	11	0	0	0	11
MUSCULAR	1	0	0	0	1
CANCER	6	0	0	0	6
OTHER TUMOR	2	0	0	1	3

TABLE 11. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TYPE OF RESEARCH ACTIVITY

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY[5] REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION	TOTAL
PRODUCTIVITY AND WELL-BEING					
WORK-LEISURE	33	1	2	3	35
LEARNING	9	1	2	1	11
GROWTH	69	11	10	6	75
FOOD KNOWLEDGE APPLICATION					
MENU PLANNING	2	11	13	1	21
HANDLING	1	8	4	1	13
SELECTION	5	8	20	7	33
PROGRAMS	5	5	9	9	21
UNCLASSIFIED	210	36	16	4	245
TOTAL	823	109	112	42	959

TABLE 12. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY REQUIREMENT TYPE OF ACTIVITY SUBCATEGORIES

TYPE PROBLEM[2]	REQUIREMENTS SUBCATEGORIES[8] DIGESTION-ABSORPTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
	(THOUSAND DOLLARS)					
PHYSIOLOGICAL						
HEART	234	3370	773	386	0	4763
RESPIRATORY	37	0	0	0	0	37
MENTAL	15	517	290	32	0	854
REPRODUCTIVE	0	566	404	180	0	1150
EARLY AGING	44	317	532	115	0	1008
ARTHRITIS	101	66	38	0	0	205
DENTAL	40	298	120	77	0	535
DIABETES	107	671	89	13	0	880
OSTEOPOROSIS	0	190	64	2	0	256
OBESITY	40	762	27	191	0	1020
ANEMIA	282	993	342	272	0	1889
ALCOHOLISM	0	391	0	0	0	391
EYE SIGHT	0	52	42	42	0	136
COSMETIC	0	68	0	0	0	68
ALLERGIES	0	0	0	18	0	18
URINARY	32	228	27	0	0	287
MUSCULAR	0	6	0	0	0	6
CANCER	0	159	0	0	0	159
OTHER TUMOR	0	56	0	0	0	56

TABLE 12. CONTINUED

TYPE PROBLEM[2]	REQUIREMENT SUBCATEGORIES[8] DIGESTION-ABOSRPTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
	(THOUSAND DOLLARS)					
PRODUCTIVITY AND WELL-BEING						
WORK-LEISURE	150	271	499	213	0	1133
LEARNING	0	111	90	2	0	203
GROWTH	116	672	568	1284	13	2652
FOOD KNOWLEDGE APPLICATION						
MENU PLANNING	0	25	6	0	0	31
HANDLING	0	0	25	0	0	25
SELECTION	32	0	20	14	0	66
PROGRAMS	0	0	100	29	0	129
UNCLASSIFIED	435	3706	1262	420	18	5823
TOTAL	1665	13498	5317	3290	31	23798

[t]Less than $500.

TABLE 13. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY REQUIREMENT TYPE OF ACTIVITY SUBCATEGORIES

TYPE PROBLEM[2]	REQUIREMENTS SUBCATEGORIES[8] DIGESTION-ABSORPTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
PHYSIOLOGICAL						
HEART	9	133	11	18	0	171
RESPIRATORY	2	0	0	0	0	2
MENTAL	1	20	11	1	0	33
REPRODUCTIVE	0	25	10	8	0	43
EARLY AGING	2	12	10	5	0	29
ARTHRITIS	3	3	1	0	0	7
DENTAL	1	10	4	3	0	18
DIABETES	3	27	3	1	0	34
OSTEOPOROSIS	0	8	2	1	0	11
OBESITY	1	22	2	5	0	30
ANEMIA	9	38	12	10	0	69
ALCOHOLISM	0	9	0	0	0	9
EYE SIGHT	0	3	3	2	0	8
COSMETIC	0	4	0	0	0	4
ALLERGIES	0	0	0	1	0	1
URINARY	1	9	1	0	0	11
MUSCULAR	0	1	0	0	0	1
CANCER	0	6	0	0	0	6
OTHER TUMOR	0	2	0	0	0	2

TABLE 13. CONTINUED

TYPE PROBLEM[2]	REQUIREMENTS SUBCATEGORIES[8] DIGESTION-ABSORPTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
PRODUCTIVITY AND WELL-BEING						
WORK-LEISURE	4	11	13	5	0	33
LEARNING	0	6	2	1	0	9
GROWTH	3	28	23	14	1	69
FOOD KNOWLEDGE APPLICATION						
MENU PLANNING	0	1	1	0	0	2
HANDLING	0	0	1	0	0	1
SELECTION	2	0	1	2	0	5
PROGRAMS	0	0	1	4	0	5
UNCLASSIFIED	19	133	42	15	1	210
TOTAL	60	511	154	96	2	823

TABLE 14. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF RESEARCH ACTIVITIES SUBCATEGORIES

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
PHYSIOLOGICAL							
HEART	0	15	413	428	7	0	7
RESPIRATORY	0	0	0	0	0	0	0
MENTAL	0	3	11	14	23	0	23
REPRODUCTIVE	0	7	50	58	3	2	5
EARLY AGING	0	0	73	73	0	0	0
ARTHRITIS	0	0	0	0	0	0	0
DENTAL	0	20	0	20	0	0	0
DIABETES	0	5	0	5	118	20	138
OSTEOPOROSIS	0	0	0	0	0	0	0
OBESITY	0	50	305	355	20	0	20
ANEMIA	0	0	46	46	0	0	0
ALCOHOLISM	0	0	0	0	0	0	0
EYE SIGHT	0	0	23	23	11	0	11
COSMETIC	0	0	0	0	0	0	0
ALLERGIES	0	0	0	0	0	0	0
URINARY	0	0	0	0	0	0	0
MUSCULAR	0	0	0	0	0	0	0
CANCER	0	0	0	0	0	0	0
OTHER TUMOR	0	0	0	0	20	20	40

TABLE 14. CONTINUED

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY SUBCATEGORIES: CONSUMPTION[9] EXPEND.	PRACTICES	INTAKE	TOTAL	* IMPLEMENTATION[10] EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
PRODUCTIVITY WELL-BEING							
WORK-LEISURE	0	0	15	15	129	10	139
LEARNING	0	0	14	14	14	0	14
GROWTH	1	1	422	423	186	235	420
FOOD KNOWLEDGE APPLICATION							
MENU PLANNING	0	171	0	171	0	12	12
HANDLING	0	176	0	176	0	12	12
SELECTION	132	96	346	574	69	54	123
PROGRAMS	5	97	51	152	126	118	243
UNCLASSIFIED	16	24	305	346	77	0	77
TOTAL	154	666	2074	2894	803	482	1285

TABLE 15. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF RESEARCH ACTIVITIES SUBCATEGORIES

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
PHYSIOLOGICAL							
HEART	0	1	12	12	2	0	2
RESPIRATORY	0	0	0	0	0	0	0
MENTAL	0	1	1	2	1	0	1
REPRODUCTIVE	0	2	4	4	1	1	1
EARLY AGING	0	0	3	3	0	0	0
ARTHRITIS	0	0	0	0	0	0	0
DENTAL	0	1	0	1	0	0	0
DIABETES	0	1	0	1	1	1	2
OSTEOPOROSIS	0	0	0	0	0	0	0
OBESITY	0	2	5	7	1	0	1
ANEMIA	0	0	4	4	0	0	0
ALCOHOLISM	0	0	0	0	0	0	0
EYE SIGHT	0	0	2	2	2	1	2
COSMETIC	0	0	0	0	0	0	0
ALLERGIES	0	0	0	0	0	0	0
URINARY	0	0	0	0	0	0	0
MUSCULAR	0	0	0	0	0	0	0
CANCER	0	0	0	0	0	0	0
OTHER TUMOR	0	0	0	0	1	1	1

TABLE 15. CONTINUED

TYPE PROBLEM[2]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
PRODUCTIVITY AND WELL-BEING							
WORK-LEISURE	0	0	2	2	2	1	3
LEARNING	0	0	2	2	1	0	1
GROWTH	1	1	10	10	3	5	6
FOOD KNOWLEDGE APPLICATION							
MENU PLANNING	0	13	0	13	0	1	1
HANDLING	0	4	0	4	0	1	1
SELECTION	7	10	18	20	6	2	7
PROGRAMS	2	4	7	9	4	6	9
UNCLASSIFIED	4	4	13	16	4	0	4
TOTAL	14	43	82	112	29	20	42

TABLE 16. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TYPE OF NUTRIENTS

TYPE PROBLEM[2]	NUTRIENTS[7]							TOTAL
	CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	
	(THOUSAND DOLLARS)							
PHYSIOLOGICAL								
HEART	221	2983	323	199	310	25	231	4293
RESPIRATORY	5	5	9	0	3	3	0	25
MENTAL	73	41	189	42	246	0	192	782
REPRODUCTIVE	175	40	272	129	274	17	137	1045
EARLY AGING	85	25	467	52	66	40	270	1005
ARTHRITIS	0	11	38	121	0	0	35	205
DENTAL	32	12	3	330	20	0	79	476
DIABETES	483	42	19	46	5	7	143	745
OSTEOPOROSIS	0	0	2	124	97	0	16	240
OBESITY	53	196	17	30	8	226	325	855
ANEMIA	2	36	229	714	768	4	98	1849
ALCOHOLISM	0	2	34	131	96	2	51	315
EYE SIGHT	32	3	24	0	13	0	50	121
COSMETIC	0	45	0	18	5	0	0	68
ALLERGIES	0	0	18	0	0	0	0	18
URINARY	11	23	72	106	0	2	0	213
MUSCULAR	0	0	0	6	0	0	0	6
CANCER	0	47	7	0	11	0	60	125
OTHER TUMOR	0	0	45	0	0	0	0	45

TABLE 16. CONTINUED

TYPE PROBLEM[2]	NUTRIENTS[7]							TOTAL
	CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	
	(THOUSAND DOLLARS)							
PRODUCTIVITY AND WELL-BEING								
WORK-LEISURE	40	71	289	118	72	62	361	1013
LEARNING	0	11	19	2	8	0	133	173
GROWTH	36	66	740	1025	56	12	620	2556
FOOD KNOWLEDGE APPLICATION								
MENU PLANNING	0	5	32	0	43	0	74	154
HANDLING	t	44	62	1	1	0	73	183
SELECTION	3	20	25	12	38	5	47	151
PROGRAMS	0	2	223	7	2	0	54	288
UNCLASSIFIED	437	717	1912	1241	1037	89	840	6273
TOTAL	1689	4447	5071	4456	3180	493	3887	23223

[t]Less than $500.

TABLE 17. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TYPE OF NUTRIENTS

TYPE PROBLEM[2]	NUTRIENTS[7]							TOTAL
	CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	
PHYSIOLOGICAL								
HEART	26	127	24	12	18	2	17	172
RESPIRATORY	1	1	1	0	1	1	0	2
MENTAL	5	5	11	3	8	0	8	32
REPRODUCTIVE	5	4	17	9	15	3	6	43
EARLY AGING	4	3	11	3	2	1	11	30
ARTHRITIS	0	1	1	3	0	0	2	7
DENTAL	2	1	1	11	1	0	4	18
DIABETES	28	5	6	7	2	1	5	35
OSTEOPOROSIS	0	0	1	8	5	0	1	11
OBESITY	9	13	4	3	1	9	10	30
ANEMIA	1	4	13	32	31	1	4	70
ALCOHOLISM	0	1	2	5	5	1	1	9
EYE SIGHT	2	1	3	0	2	0	3	8
COSMETIC	0	2	0	1	1	0	0	4
ALLERGIES	0	0	1	0	0	0	0	1
URINARY	1	1	7	6	0	1	0	11
MUSCULAR	0	0	0	1	0	0	0	1
CANCER	0	4	2	0	2	0	1	6
OTHER TUMOR	0	0	2	0	0	0	0	2

TABLE 17. CONTINUED

TYPE PROBLEM[2]	NUTRIENTS[7] CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	TOTAL
PRODUCTIVITY AND WELL-BEING								
WORK-LEISURE	3	5	18	6	4	4	9	32
LEARNING	0	3	2	1	3	0	4	9
GROWTH	1	6	39	19	6	1	18	70
FOOD KNOWLEDGE APPLICATION								
MENU PLANNING	0	2	2	0	5	0	3	12
HANDLING	1	4	3	1	1	0	2	8
SELECTION	1	2	4	2	3	1	4	11
PROGRAMS	0	1	4	2	1	0	5	9
UNCLASSIFIED	32	54	103	51	63	8	24	229
TOTAL	122	250	282	186	180	34	142	872

TABLE 18. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TARGET GROUP

TYPE PROBLEM[2]	TARGET GROUPS[6] UNDER 1 YR	1-6 YRS	7-12 YRS	13-19 YRS	20-35 YRS	36-60 YRS	OVER 60 Yrs	IN-FIRM	PREG & LAC	ALL FEMALES	ALL MALES	NONSPE-CIFIC	TOTAL
	(THOUSAND DOLLARS)												
PHYSIOLOGICAL													
HEART	16	42	52	52	146	318	546	317	51	0	0	3822	5361
RESPIRATORY	0	0	0	0	0	0	0	0	10	0	0	27	37
MENTAL	101	125	78	57	7	0	4	4	40	0	0	496	911
REPRODUCTIVE	701	329	54	16	6	16	16	9	0	0	37	29	1213
EARLY AGING	322	0	2	3	52	63	79	59	3	24	0	529	1137
ARTHRITIS	0	0	0	0	0	19	32	13	0	0	0	142	205
DENTAL	10	10	5	9	9	4	8	8	0	0	0	519	582
DIABETES	0	0	18	18	0	57	45	34	172	0	0	685	1031
OSTEOPOROSIS	0	20	10	10	0	0	0	0	0	0	0	216	256
OBESITY	16	16	8	42	49	130	261	99	0	0	0	774	1395
ANEMIA	90	37	39	17	19	78	22	7	40	41	0	1656	2045
ALCOHOLISM	0	0	0	0	0	32	66	21	0	0	0	272	391
EYE SIGHT	0	14	14	14	0	0	0	0	0	0	0	133	176
COSMETIC	0	0	0	0	0	0	0	0	0	0	0	68	68
ALLERGIES	0	9	9	0	0	0	0	0	0	0	0	0	18
URINARY	0	0	0	0	0	0	0	0	0	0	0	287	287
MUSCULAR	0	0	0	0	0	0	0	0	0	0	0	6	6
CANCER	0	0	0	0	0	0	0	0	0	0	0	159	159
OTHER TUMOR	0	0	0	0	0	0	0	20	60	0	0	16	96

TABLE 18. CONTINUED

TYPE PROBLEM[2]	TARGET GROUPS[6] UNDER 1 YR	1-6 YRS	7-12 YRS	13-19 YRS	20-35 Yrs	36-60 YRS	OVER 60 YRS	IN-FIRM	PREG & LAC	ALL FEMALE	ALL MALE	NONSPE-CIFIC	TOTAL
	(THOUSAND DOLLARS)												
PRODUCTIVITY AND WELL-BEING													
WORK-LEISURE	0	0	t	t	16	347	264	36	0	16	0	632	1312
LEARNING	t	87	73	11	0	0	0	t	t	0	0	60	231
GROWTH	190	466	1597	240	94	3	t	5	t	0	0	1006	3602
FOOD KNOWLEDGE APPLICATION													
MENU PLANNING	0	0	0	1	1	1	1	1	0	0	0	330	337
HANDLING	0	0	0	0	6	41	15	0	0	0	0	310	372
SELECTION	1	3	51	6	11	51	36	41	0	0	0	698	897
PROGRAMS	0	6	81	65	54	16	2	2	0	0	0	469	695
UNCLASSIFIED	20	225	313	179	127	610	119	8	172	29	22	5672	7496
TOTAL	1468	1390	2404	740	596	1788	1516	684	548	110	59	19013	30316

[t]Less than $500.

TABLE 19. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY TARGET GROUP

TYPE PROBLEM[2]	TARGET GROUPS[6] UNDER 1 YR	1-6 YRS	7-12 YRS	13-19 YRS	20-35 YRS	36-60 YRS	OVER 60 YRS	IN-FIRM	PREG & LAC	ALL FEMALE	ALL MALE	NONSPE-CIFIC	TOTAL
PHYSIOLOGICAL													
HEART	1	4	4	4	10	29	35	26	4	0	0	127	176
RESPIRATORY	0	0	0	0	0	0	0	0	1	0	0	1	2
MENTAL	5	9	7	5	1	0	1	1	1	0	0	16	33
REPRODUCTIVE	28	16	5	2	1	2	2	1	0	0	1	2	43
EARLY AGING	2	0	1	2	4	7	8	7	1	1	0	18	30
ARTHRITIS	0	0	0	0	0	1	2	1	0	0	0	5	7
DENTAL	1	1	2	2	2	1	1	1	0	0	0	16	19
DIABETES	0	0	2	2	0	4	4	3	3	0	0	27	36
OSTEOPOROSIS	0	1	1	1	0	0	0	0	0	0	0	10	11
OBESITY	2	2	2	3	3	4	7	1	0	0	0	25	35
ANEMIA	6	7	6	4	5	5	3	2	1	1	0	52	70
ALCOHOLISM	0	0	0	0	0	3	3	3	0	0	0	6	9
EYE SIGHT	0	1	1	1	0	0	0	0	0	0	0	7	8
COSMETIC	0	0	0	0	0	0	0	0	0	0	0	4	4
ALLERGIES	0	1	1	0	0	0	0	0	0	0	0	0	1
URINARY	0	0	0	0	0	0	0	0	0	0	0	11	11
MUSCULAR	0	0	0	0	0	0	0	0	0	0	0	1	1
CANCER	0	0	0	0	0	0	0	0	0	0	0	6	6
OTHER TUMOR	0	0	0	0	0	0	0	1	2	0	0	1	3

TABLE 19. CONTINUED

TYPE PROBLEM[2]	TARGET GROUPS[6] UNDER 1 YR	1-6 YRS	7-12 YRS	13-19 YRS	20-35 YRS	36-60 YRS	OVER 60 YRS	IN-FIRM	PREG & LAC	ALL FEMALE	ALL MALE	NONSPE-CIFIC	TOTAL
PRODUCTIVITY AND WELL-BEING													
WORK-LEISURE	0	2	0	0	2	17	14	1	0	1	0	17	35
LEARNING	0	6	6	2	0	0	0	0	0	0	0	4	11
GROWTH	7	21	23	18	8	1	0	1	0	0	0	35	75
FOOD KNOWLEDGE APPLICATION													
MENU PLANNING	0	0	0	1	1	1	1	1	0	0	0	20	21
HANDLING	0	0	0	0	1	2	1	0	0	0	0	11	13
SELECTION	1	3	6	2	4	5	4	2	0	0	0	21	33
PROGRAMS	1	1	4	6	4	1	1	1	0	0	0	10	21
UNCLASSIFIED	3	15	14	14	14	22	8	2	3	1	1	197	245
TOTAL	57	90	83	68	59	105	95	55	16	4	2	649	959

TABLE 20. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRITION-RELATED PROBLEM AND BY BIOLOGICAL MODEL

TYPE PROBLEM[2]	BIOLOGICAL MODEL[4] HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	TOTAL
	(THOUSAND DOLLARS)							
PHYSIOLOGICAL								
HEART	1803	2452	249	87	402	140	228	5361
RESPIRATORY	10	27	0	0	0	0	0	37
MENTAL	473	328	74	0	4	32	0	911
REPRODUCTIVE	718	443	0	0	0	42	10	1213
EARLY AGING	334	696	77	0	0	30	0	1137
ARTHRITIS	49	156	0	0	0	0	0	205
DENTAL	153	326	0	30	0	23	50	582
DIABETES	509	354	0	0	10	158	0	1031
OSTEOPOROSIS	110	146	0	0	0	0	0	256
OBESITY	777	480	10	0	0	118	10	1395
ANEMIA	584	982	178	0	165	70	66	2045
ALCOHOLISM	120	222	0	0	0	0	49	391
EYE SIGHT	86	78	0	0	0	0	12	176
COSMETIC	45	23	0	0	0	0	0	68
ALLERGIES	0	0	0	0	0	18	0	18
URINARY	144	143	0	0	0	0	0	287
MUSCULAR	0	6	0	0	0	0	0	6
CANCER	6	61	25	7	0	0	60	159
OTHER TUMOR	40	16	40	0	0	0	0	96

TABLE 20. CONTINUED

TYPE PROBLEM[2]	BIOLOGICAL MODEL[4] HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	TOTAL
	(THOUSAND DOLLARS)							
PRODUCTIVITY AND WELL-BEING								
WORK-LEISURE	821	272	0	30	42	147	0	1312
LEARNING	51	116	7	0	0	0	57	231
GROWTH	1643	804	85	46	1	1023	0	3602
FOOD KNOWLEDGE APPLICATION								
MENU PLANNING	0	82	0	0	179	10	66	337
HANDLING	0	50	0	0	61	0	261	372
SELECTION	88	76	0	30	35	610	58	897
PROGRAMS	185	14	0	200	0	95	201	695
UNCLASSIFIED	2227	2938	385	144	703	482	617	7496
TOTAL	10976	11291	1130	574	1602	2998	1745	30316

TABLE 21. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRITION-RELATED PROBLEM AND BY BIOLOGICAL MODEL

TYPE PROBLEM[2]	BIOLOGICAL MODEL[4] HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	TOTAL
PHYSIOLOGICAL								
HEART	47	97	10	3	5	9	5	176
RESPIRATORY	1	1	0	0	0	0	0	2
MENTAL	16	13	2	0	1	1	0	33
REPRODUCTIVE	17	23	0	0	0	2	1	43
EARLY AGING	6	20	3	0	0	1	0	30
ARTHRITIS	2	5	0	0	0	0	0	7
DENTAL	5	10	0	1	0	2	1	19
DIABETES	19	14	0	0	1	2	0	36
OSTEOPOROSIS	4	7	0	0	0	0	0	11
OBESITY	14	17	1	0	0	2	1	35
ANEMIA	19	36	5	0	5	2	3	70
ALCOHOLISM	4	4	0	0	0	0	1	9
EYE SIGHT	4	3	0	0	0	0	1	8
COSMETIC	2	2	0	0	0	0	0	4
ALLERGIES	0	0	0	0	0	1	0	1
URINARY	5	6	0	0	0	0	0	11
MUSCULAR	0	1	0	0	0	0	0	1
CANCER	1	2	1	1	0	0	1	6
OTHER TUMOR	1	1	1	0	0	0	0	3

TABLE 21. CONTINUED

TYPE PROBLEM[2]	BIOLOGICAL MODEL[4] HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	TOTAL
PRODUCTIVITY AND WELL-BEING								
WORK-LEISURE	22	7	0	1	2	3	0	35
LEARNING	4	5	1	0	0	0	1	11
GROWTH	32	29	3	1	1	9	0	75
FOOD KNOWLEDGE APPLICATION								
MENU PLANNING	0	3	0	0	10	1	7	21
HANDLING	0	1	0	0	2	0	10	13
SELECTION	4	3	0	1	2	19	4	33
PROGRAMS	5	1	0	1	0	9	5	21
UNCLASSIFIED	60	108	16	5	21	18	17	245
TOTAL	294	419	43	14	50	81	58	959

TABLE 22. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE AGENCY SUPPORTING RESEARCH AND TARGET GROUP

TYPE AGENCY SUPPORTING	TARGET GROUPS[6] UNDER 1 YR	1-6 YRS	7-12 YRS	13-19 YRS	20-35 YRS	36-60 YRS	OVER 60 YRS	IN-FIRM	PREG & LAC	ALL FEMALE	ALL MALE	NONSPE-CIFIC	TOTAL
	(THOUSAND DOLLARS)												
USDA	24	50	136	188	185	560	206	191	2	51	0	2122	3715
HEW	1183	1094	888	350	246	491	788	340	306	41	59	11745	17528
NSF	0	0	3	3	3	3	3	0	0	0	0	343	360
AEC	0	0	0	0	10	10	0	0	0	0	0	69	89
DOD	102	128	43	35	30	500	320	0	25	0	0	1606	2789
NASA	0	0	0	0	0	12	12	0	0	0	0	48	72
VA	10	30	14	18	21	66	121	119	200	0	0	1200	1800
OEO	0	0	1143	0	0	0	0	0	0	0	0	0	1143
OTHER FED	0	4	36	30	30	0	0	0	0	0	0	147	246
STATE GOV	105	29	94	87	53	139	40	25	0	18	0	991	1580
UNIVERSITY	0	0	0	10	10	0	0	0	0	0	0	0	20
FOUNDATION	43	39	30	12	4	5	15	9	15	0	0	664	837
HOSPITAL	0	0	0	0	0	0	0	0	0	0	0	0	0
INDUSTRY	0	14	14	7	0	0	0	0	0	0	0	34	68
OTHER	0	7	3	0	4	0	11	0	0	0	0	44	69
TOTAL	1468	1390	2404	740	596	1788	1516	684	548	110	59	19013	30316

TABLE 23. NUMBERS OF RESEARCH PROJECTS BY TYPE AGENCY SUPPORTING RESEARCH AND BY TARGET GROUP

TYPE AGENCY SUPPORTING	TARGET GROUPS[6]												
	UNDER 1 YR	1-6 YRS	7-12 YRS	13-19 YRS	20-35 YRS	36-60 YRS	OVER 60 YRS	IN-FIRM	PREG & LAC	ALL FEMALE	ALL MALE	NONSPE-CIFIC	TOTAL
USDA	6	13	21	27	26	35	23	21	2	3	0	111	183
HEW	40	59	40	28	16	30	36	24	5	1	2	371	517
NSF	0	0	1	1	1	1	1	0	0	0	0	18	19
AEC	0	0	0	0	1	1	0	0	0	0	0	3	4
DOD	2	4	3	3	4	23	20	0	1	0	0	40	72
NASA	0	0	0	0	0	2	2	0	0	0	0	5	7
VA	1	2	2	2	2	5	7	6	6	0	0	30	45
OEO	0	0	2	0	0	0	0	0	0	0	0	0	2
OTHER FED	0	1	1	1	1	0	0	0	0	0	0	6	8
STATE GOV	12	15	23	21	21	28	14	10	1	3	0	116	186
UNIVERSITY	0	0	0	1	1	0	0	0	0	0	0	0	1
FOUNDATION	5	7	5	2	2	3	4	3	2	0	0	57	72
HOSPITAL	0	0	0	0	0	0	0	0	0	0	0	0	0
INDUSTRY	0	1	1	1	0	0	0	0	0	0	0	1	2
OTHER	0	1	1	0	1	0	1	0	0	0	0	6	9
TOTAL	57	90	83	68	59	105	95	55	16	4	2	649	959

TABLE 24. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY TYPE AGENCY PERFORMING RESEARCH

TARGET GROUPS[6]	TYPE AGENCY PERFORMING RESEARCH							TOTAL
	UNIVER-SITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	FOUNDA-TIONS	HOSPITAL	OTHER	
	(THOUSAND DOLLARS)							
UNDER 1 YR	1062	177	0	0	0	229	0	1468
1-6 YRS	844	182	0	3	92	233	36	1390
7-12 YRS	1413	61	0	3	457	417	52	2404
13-19 YRS	524	117	0	4	0	70	25	740
20-35 YRS	441	107	0	4	0	29	15	596
36-60 YRS	762	698	0	4	99	207	18	1788
OVER 60 YR	647	373	84	7	124	263	18	1516
INFIRM	276	161	0	10	26	211	0	684
PREG & LAC	232	43	0	0	118	155	0	548
ALL FEMALE	110	0	0	0	0	0	0	110
ALL MALE	22	0	0	0	37	0	0	59
UNSPECI.	13046	3845	165	139	934	851	33	19013
TOTAL	19380	5765	249	174	1886	2665	197	30316

TABLE 25. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY TYPE AGENCY PERFORMING RESEARCH

TARGET GROUPS[6]	TYPE AGENCY PERFORMING RESEARCH							TOTAL
	UNIVERSITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	FOUNDATIONS	HOSPITAL	OTHER	
UNDER 1 YR	42	6	0	0	0	9	0	57
1-6 YRS	62	8	2	1	4	12	1	90
7-12 YRS	60	5	0	1	2	12	3	83
13-19 YRS	48	8	0	2	0	8	2	68
20-35 YRS	44	8	0	2	0	4	1	59
36-60 YRS	67	19	0	2	6	10	1	105
OVER 60 YR	55	16	1	2	8	12	1	95
INFIRM	36	6	0	2	3	8	0	55
PREG & LAC	7	2	0	0	1	6	0	16
ALL FEMALE	4	0	0	0	0	0	0	4
ALL MALE	1	0	0	0	1	0	0	2
UNSPECI.	485	82	3	6	34	37	2	649
TOTAL	697	117	4	8	49	77	7	959

TABLE 26. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY REGION

TARGET GROUPS[6]	REGION[1] NE	E	SE	EC	NC	C	SW	M	W	F	TOTAL
	(THOUSAND DOLLARS)										
UNDER 1 YR	661	169	77	165	25	19	42	28	182	100	1468
1-6 YRS	420	231	52	99	154	93	109	15	128	89	1390
7-12 YRS	739	214	19	271	787	53	32	23	156	111	2404
13-19 YRS	207	144	103	46	10	27	18	16	97	72	740
20-35 YRS	203	94	89	37	39	19	24	14	41	36	596
36-60 YRS	342	480	54	162	89	92	171	64	268	65	1788
OVER 60 YR	368	200	43	188	60	111	134	42	312	57	1516
INFIRM	213	159	77	80	16	50	3	8	68	8	684
PREG & LAC	94	3	11	60	201	119	5	0	55	0	548
ALL FEMALE	70	16	0	0	24	0	0	0	0	0	110
ALL MALE	0	0	0	0	22	37	0	0	0	0	59
UNSPECI.	4680	2697	1090	1650	2099	2030	822	701	2718	526	19013
TOTAL	7997	4407	1615	2759	3525	2651	1361	911	4025	1065	30316

TABLE 27. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY REGION

TARGET GROUPS[6]	REGION[1] NE	E	SE	EC	NC	C	SW	M	W	F	TOTAL
UNDER 1 YR	13	8	2	8	3	4	4	1	10	4	57
1-6 YRS	23	13	2	11	3	10	6	3	11	8	90
7-12 YRS	18	12	3	11	6	8	3	3	8	11	83
13-19 YRS	13	13	8	7	2	5	3	2	6	9	68
20-35 YRS	14	8	9	5	4	2	4	3	5	5	59
36-60 YRS	19	12	11	12	9	5	10	5	17	5	105
OVER 60 YR	17	11	7	10	6	7	9	5	18	5	95
INFIRM	12	9	6	6	3	6	1	2	8	2	55
PREG & LAC	3	1	2	2	2	2	1	0	3	0	16
ALL FEMALE	2	1	0	0	1	0	0	0	0	0	4
ALL MALE	0	0	0	0	1	1	0	0	0	0	2
UNSPECI.	147	85	54	79	52	62	25	28	94	23	649
TOTAL	217	122	79	114	78	85	46	38	134	46	959

TABLE 28. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY TYPE RESEARCH ACTIVITY

TARGET GROUPS[6]	TYPE RESEARCH ACTIVITY[5] REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION	TOTAL
	(THOUSAND DOLLARS)				
UNDER 1 YR	1279	47	103	38	1468
1-6 YRS	1244	10	119	17	1390
7-12 YRS	1579	27	395	403	2404
13-19 YRS	583	13	90	54	740
20-35 YRS	471	21	81	23	596
36-60 YRS	1576	83	86	42	1788
OVER 60 YR	1378	18	89	31	1516
INFIRM	572	3	69	40	684
PREG & LAC	349	21	1	178	548
ALL FEMALE	96	15	0	0	110
ALL MALE	59	0	0	0	59
UNSPECI.	14611	2081	1860	461	19013
TOTAL	23798	2339	2894	1285	30316

TABLE 29. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY TYPE RESEARCH ACTIVITY

TARGET GROUPS[6]	TYPE RESEARCH ACTIVITY[5]				TOTAL
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION	
UNDER 1 YR	54	2	7	5	57
1-6 YRS	83	2	12	6	90
7-12 YRS	75	3	20	5	83
13-19 YRS	60	3	15	5	68
20-35 YRS	50	4	14	5	59
36-60 YRS	96	1	15	5	105
OVER 60 YR	88	4	13	4	95
INFIRM	49	2	9	2	55
PREG & LAC	13	2	1	3	16
ALL FEMALE	4	1	0	0	4
ALL MALE	2	0	0	0	2
UNSPECI.	543	91	61	23	649
TOTAL	823	109	112	42	959

TABLE 30. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY REQUIREMENTS TYPE OF ACTIVITY SUBCATEGORIES

TARGET GROUPS[6]	REQUIREMENT SUBCATEGORIES[8] DIGESTION-ABSORPTION	METABOLISM-FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
	(THOUSAND DOLLARS)					
UNDER 1 YR	9	488	651	131	0	1279
1-6 YRS	53	537	413	242	0	1244
7-12 YRS	47	332	190	1010	0	1579
13-19 YRS	15	251	134	182	0	583
20-35 YRS	18	156	99	198	0	471
36-60 YRS	103	867	471	135	0	1576
OVER 60 YR	132	635	369	242	0	1378
INFIRM	3	420	90	59	0	572
PREG & LAC	10	246	90	2	0	349
ALL FEMALE	0	45	41	24	0	96
ALL MALE	0	31	0	0	0	59
UNSPECI.	1275	9473	2769	1064	31	14611
TOTAL	1665	13495	5317	3290	31	23798

TABLE 31. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY REQUIREMENTS TYPE OF ACTIVITY SUBCATEGORIES

TARGET GROUPS[6]	REQUIREMENTS SUBCATEGORIES[8] DISGESTION-ABSORPTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
UNDER 1 YR	1	33	14	6	0	54
1-6 YRS	4	43	20	16	0	83
7-12 YRS	3	35	14	23	0	73
13-19 YRS	3	28	11	18	0	60
20-35 YRS	4	21	9	16	0	50
36-60 YRS	7	50	24	15	0	96
OVER 60 YR	6	46	21	15	0	88
INFIRM	1	34	7	7	0	49
PREG & LAC	1	7	4	1	0	13
ALL FEMALE	0	2	1	1	0	4
ALL MALE	0	2	0	0	0	2
UNSPECI.	47	380	82	34	2	545
TOTAL	60	511	154	96	2	825

TABLE 32. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF ACTIVITIES CATEGORIES

TARGET GROUPS[6]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
UNDER 1 YR	0	3	100	107	23	15	38
1-6 YRS	t	7	112	119	83	6	17
7-12 YRS	1	22	372	395	176	227	403
13-19 YRS	1	36	53	90	22	32	54
20-35 YRS	t	41	40	81	1	22	23
36-60 YRS	t	8	78	86	3	39	42
OVER 60 YR	1	9	79	89	1	30	31
INFIRM	1	9	59	69	40	0	40
PREG & LAC	0	0	1	1	138	40	178
ALL FEMALE	0	0	0	0	0	0	0
ALL MALE	0	0	0	0	0	0	0
UNSPECI.	150	531	1178	1860	389	72	461
TOTAL	154	666	2074	2894	803	482	1285

[t]Less than $500.

TABLE 33. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF ACTIVITIES SUBCATEGORIES

TARGET GROUPS[6]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
UNDER 1 YR	0	1	7	7	4	3	5
1-6 YRS	1	4	11	12	5	1	6
7-12 YRS	2	6	17	20	3	3	5
13-19 YRS	1	4	12	15	2	3	5
20-35 YRS	1	5	11	14	2	4	5
36-60 YRS	1	5	12	15	2	4	5
OVER 60 YR	1	2	11	13	2	2	4
INFIRM	1	2	7	9	2	0	2
PREG & LAC	0	0	1	1	2	2	3
ALL FEMALE	0	0	0	0	0	0	0
ALL MALE	0	0	0	0	0	0	0
UNSPECI.	9	30	39	61	18	7	23
TOTAL	14	43	82	112	29	20	42

TABLE 34. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY TYPE OF NUTRIENTS

TARGET GROUPS[6]	NUTRIENTS[7] CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	TOTAL
	(THOUSAND DOLLARS)							
UNDER 1 YR	171	46	537	112	213	6	164	1250
1-6 YRS	33	56	399	91	107	15	446	1147
7-12 YRS	33	57	249	797	35	16	341	1527
13-19 YRS	54	57	156	92	35	7	122	523
20-35 YRS	24	96	85	91	25	38	54	413
36-60 YRS	201	252	276	140	73	100	318	1360
OVER 60 YR	118	301	15	104	66	190	322	1217
INFIRM	41	232	58	32	12	35	97	508
PREG & LAC	22	70	62	58	56	7	2	276
ALL FEMALE	0	0	59	20	0	0	24	103
ALL MALE	0	0	11	0	48	0	0	59
UNSPECI.	992	3279	3063	2918	2509	79	1997	14837
TOTAL	1689	4447	5071	4456	3180	493	3887	23223

TABLE 35. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY TYPE OF NUTRIENTS

TARGET GROUPS[6]	NUTRIENTS[7]							TOTAL
	CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	
UNDER 1 YR	5	6	22	11	15	2	8	55
1-6 YRS	7	14	35	15	14	4	22	83
7-12 YRS	8	13	28	20	12	4	23	75
13-19 YRS	9	13	26	21	11	3	15	62
20-35 YRS	6	16	17	13	8	6	10	52
36-60 YRS	18	34	33	15	12	11	24	98
OVER 60 YR	13	31	21	12	8	12	28	89
INFIRM	6	25	14	7	7	3	12	51
PREG & LAC	4	7	5	2	4	1	1	14
ALL FEMALE	0	0	3	1	0	0	1	4
ALL MALE	0	0	1	0	2	0	0	2
UNSPECI.	86	184	178	128	134	13	74	589
TOTAL	122	250	282	186	180	34	141	872

TABLE 36. TOTAL DOLLARS RESEARCH SUPPORT BY TARGET GROUPS AND BY BIOLOGICAL MODEL

TARGET GROUPS[6]	BIOLOGICAL MODEL[4]							TOTAL
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	
	(THOUSAND DOLLARS)							
UNDER 1 YR	759	641	0	0	0	57	10	1468
1-6 YRS	769	414	4	16	0	160	29	1390
7-12 YRS	1067	363	4	16	0	925	29	2404
13-19 YRS	274	213	0	16	1	190	46	740
20-35 YRS	339	138	0	16	1	66	37	596
36-60 YRS	1268	363	0	3	39	91	24	1788
OVER 60 YR	786	441	15	3	19	213	39	1516
INFIRM	263	303	30	6	4	75	5	684
PREG & LAC	366	40	20	0	1	121	0	548
ALL FEMALE	110	0	0	0	0	0	0	110
ALL MALE	22	37	0	0	0	0	0	59
UNSPECI.	4954	8338	1058	499	1537	1100	1527	19013
TOTAL	10976	11291	1130	574	1602	2998	1745	30316

TABLE 37. NUMBERS OF RESEARCH PROJECTS BY TARGET GROUPS AND BY BIOLOGICAL MODEL

TARGET GROUP [6]	BIOLOGICAL MODEL[4]							TOTAL
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	
UNDER 1 YR	17	35	0	0	0	4	1	57
1-6 YRS	38	40	1	1	0	10	1	90
7-12 YRS	31	34	1	1	0	17	1	83
13-19 YRS	26	27	0	1	1	12	2	68
20-35 YRS	26	20	0	1	1	9	3	59
36-60 YRS	53	33	0	1	3	12	3	105
OVER 60 YR	40	35	1	1	3	14	1	95
INFIRM	16	26	2	1	2	7	1	55
PREG & LAC	9	3	1	0	1	2	0	16
ALL FEMALE	4	0	0	0	0	0	0	4
ALL MALE	1	1	0	0	0	0	0	2
UNSPECI.	146	316	40	12	47	38	51	649
TOTAL	294	419	43	14	50	81	58	959

TABLE 38. TOTAL DOLLARS RESEARCH SUPPORT BY REGION AND BY TYPE OF NUTRIENT

REGION[1]	NUTRIENTS[7]							TOTAL
	CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	
	(THOUSAND DOLLARS)							
NORTHEAST	577	644	2016	717	978	112	873	5917
EASTERN	356	571	802	718	363	47	688	3545
SOUTHEAST	123	140	144	280	314	14	226	1241
E.CENTRAL	103	463	515	380	145	55	392	2052
N.CENTRAL	48	1061	293	857	209	11	354	2833
CENTRAL	127	274	151	509	542	42	126	1771
SOUTHWEST	45	411	206	247	42	14	206	1170
MOUNTAIN	30	141	48	109	74	0	289	692
WESTERN	274	662	775	506	503	180	400	3300
FOREIGN	6	80	121	132	10	18	335	703
TOTAL	1689	4447	5071	4456	3180	493	3887	23223

TABLE 39. NUMBERS OF RESEARCH PROJECTS BY REGION AND BY TYPE OF NUTRIENT

REGION[1]	NUTRIENTS[7]							TOTAL
	CARBO.	FATS	PROTEIN	MINERAL	VITAMINS	ENERGY	UNSPEC	
NORTHEAST	36	45	74	37	41	6	30	200
EASTERN	15	26	43	30	22	3	20	111
SOUTHEAST	9	21	24	18	22	2	8	71
E.CENTRAL	14	33	37	23	12	8	17	104
N.CENTRAL	6	28	22	10	11	1	12	72
CENTRAL	10	25	13	12	26	2	5	68
SOUTHWEST	5	17	11	10	6	2	8	44
MOUNTAIN	3	11	9	7	6	0	9	35
WESTERN	23	37	36	30	31	7	18	126
FOREIGN	1	7	13	9	3	3	14	41
TOTAL	122	250	282	186	180	34	141	872

TABLE 40. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRIENTS AND BY REQUIREMENTS AND COMPOSITION TYPES OF RESEARCH ACTIVITIES

NUTRIENTS[7]	TYPE RESEARCH ACTIVITY[5]		TOTAL
	REQUIREMENTS	COMPOSITION	
	(THOUSAND DOLLARS)		
CARBOHYD.	1583	105	1689
FATS	4148	303	4447
PROTEIN	4258	813	5071
MINERALS	3936	520	4456
VITAMINS	3006	175	3180
ENERGY	490	3	493
UNSPECI.	3584	303	3887
TOTAL	21002	2221	23223

TABLE 41. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRIENTS AND BY REQUIREMENTS AND COMPOSITION TYPES OF RESEARCH ACTIVITIES

NUTRIENTS[7]	TYPE RESEARCH ACTIVITY[5]		TOTAL
	REQUIREMENTS	COMPOSITION	
CARBOHYD.	117	8	122
FATS	234	34	251
PROTEIN	260	52	282
MINERALS	176	21	18/
VITAMINS	165	19	180
ENERGY	34	2	34
UNSPECI.	134	16	143
TOTAL	821	109	872

TABLE 42. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRIENTS AND BY REQUIREMENT TYPE OF RESEARCH ACTIVITY SUBCATEGORIES

NUTRIENTS[7]	REQUIREMENTS SUBCATEGORIES[8] DIGESTION-ABSORPTION	METABOLISM-FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
	(THOUSAND DOLLARS)					
CARBOHYD.	263	947	319	55	0	1583
FATS	267	2922	812	231	12	4144
PROTEIN	275	1995	1657	331	0	4258
MINERALS	478	1623	746	1076	13	3936
VITAMINS	131	2042	616	217	0	3006
ENERGY	37	173	151	130	0	490
UNSPECI.	95	1728	827	934	0	3584
TOTAL	1446	11430	5127	2973	25	21002

TABLE 43. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRIENTS AND BY REQUIREMENT TYPE OF RESEARCH ACTIVITY SUBCATEGORIES

	REQUIREMENTS SUBCATEGORIES[8]					
NUTRIENTS[7]	DIGESTION-ABSORBTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
CARBOHYD.	14	84	13	6	0	117
FATS	15	182	20	16	1	234
PROTEIN	18	157	66	19	0	260
MINERALS	20	99	31	25	1	176
VITAMINS	9	116	28	12	0	165
ENERGY	6	14	8	6	0	34
UNSPECI.	5	61	27	41	0	134
TOTAL	60	509	151	96	2	821

TABLE 44. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF NUTRIENT AND BY BIOLOGICAL MODEL

NUTRIENTS[7]	BIOLOGICAL MODEL[4]							TOTAL
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	
	(THOUSAND DOLLARS)							
CARBOHYD.	887	530	9	62	47	78	75	1689
FATS	1317	2184	256	70	510	34	76	4447
PROTEIN	1721	1968	228	288	374	171	322	5071
MINERALS	1877	2025	92	0	161	106	194	4456
VITAMINS	1020	1339	273	105	272	26	145	3180
ENERGY	224	158	0	0	2	99	10	493
UNSPECI.	1337	1509	152	46	39	549	256	3887
TOTAL	8383	9714	1011	570	1404	1063	1078	23223

TABLE 45. NUMBERS OF RESEARCH PROJECTS BY TYPE OF NUTRIENT AND BY BIOLOGICAL MODEL

	BIOLOGICAL MODEL[4]							TOTAL
NUTRIENTS[7]	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS	
CARBOHYD.	58	48	2	2	4	4	4	122
FATS	69	132	16	4	15	5	9	250
PROTEIN	101	127	12	6	15	8	13	282
MINERALS	68	94	5	0	5	7	7	186
VITAMINS	49	89	13	5	13	4	7	180
ENERGY	16	13	0	0	1	3	1	34
UNSPECI.	47	51	6	1	3	26	7	141
TOTAL	276	412	43	14	46	43	38	872

TABLE 46. TOTAL DOLLARS RESEARCH SUPPORT BY BIOLOGICAL MODEL AND BY TYPE RESEARCH ACTIVITY

BIOLOGICAL MODEL[4]	TYPE RESEARCH ACTIVITY[5] REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION	TOTAL
	(THOUSAND DOLLARS)				
HUMAN	9521	223	814	418	10976
ANIMAL	9960	878	440	13	11291
TIS.&CELLS	1117	14	0	0	1130
MICROORGAN	441	134	0	0	574
SUBCEL&CFB	918	543	129	12	1602
POPULATION	1135	57	1162	644	2998
UNCLASS.	706	491	349	198	1745
TOTAL	23798	2339	2894	1285	30316

TABLE 47. NUMBERS OF RESEARCH PROJECTS BY BIOLOGICAL MODEL AND BY TYPE RESEARCH ACTIVITY

BIOLOGICAL MODEL[4]	TYPE RESEARCH ACTIVITY[5]				TOTAL
	REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION	
HUMAN	277	21	22	19	294
ANIMAL	400	41	20	1	419
TIS.&CELLS	43	1	0	0	43
MICROORGAN	13	3	0	0	14
SUBCEL&CFB	24	24	7	1	50
POPULATION	40	4	47	13	81
UNCLASS.	26	15	16	8	58
TOTAL	823	109	112	42	959

TABLE 48. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF RESEARCH ACTIVITY AND BY TYPE AGENCY PERFORMING RESEARCH

TYPE AGENCY PERFORMING	TYPE RESEARCH ACTIVITY[5]			
	REQUIREMENTS	COMPOSITION	CONSUMPTION	IMPLEMENTATION
	(THOUSAND DOLLARS)			
UNIVERSITY	16484	1358	1334	205
FED AGENCY	3639	878	917	331
STA AGENCY	120	0	0	129
INDUSTRY	165	9	0	0
FOUNDATION	1239	65	112	470
HOSPITAL	2027	20	528	90
OTHER	124	10	4	60

TABLE 49. NUMBER OF RESEARCH PROJECTS BY TYPE OF RESEARCH ACTIVITY AND BY TYPE AGENCY PERFORMING RESEARCH

TYPE AGENCY PERFORMING	TYPE RESEARCH ACTIVITY[5]			
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION
UNIVERSITY	605	78	73	14
FED AGENCY	88	22	20	14
STA AGENCY	2	0	0	2
INDUSTRY	6	1	0	0
FOUNDATION	44	6	6	5
HOSPITAL	73	1	12	5
OTHER	5	1	1	2

TABLE 50. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF RESEARCH ACTIVITY AND BY TYPE AGENCY SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	TYPE RESEARCH ACTIVITY[5]			
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION
	(THOUSAND DOLLARS)			
USDA	1943	867	734	172
HEW	15016	721	1441	356
NSF	300	0	47	14
AEC	69	20	0	0
DOD	2191	221	216	161
NASA	52	20	0	0
VA	1580	20	80	120
OEO	767	0	42	334
OTHER FED	21	92	93	40
STATE GOV	1078	265	178	59
UNIVERSITY	0	0	20	0
FOUNDATION	671	113	25	28
HOSPITAL	0	0	0	0
INDUSTRY	68	0	0	0
OTHER	50	0	18	0
TOTAL	23798	2339	2894	1285

TABLE 51. NUMBER OF RESEARCH PROJECTS BY TYPE OF RESEARCH ACTIVITY AND BY TYPE OF AGENCY SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	TYPE RESEARCH ACTIVITY[5]			
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION
USDA	112	58	40	10
HEW	487	31	35	8
NSF	17	0	3	1
AEC	3	1	0	0
DOD	66	11	10	9
NASA	6	1	0	0
VA	42	1	3	4
OEO	2	0	1	1
OTHER FED	2	3	2	1
STATE GOV	128	48	34	9
UNIVERSITY	0	0	1	0
FOUNDATION	68	5	7	5
HOSPITAL	0	0	0	0
INDUSTRY	2	0	0	0
OTHER	8	0	3	0
TOTAL	823	109	112	42

TABLE 52. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF RESEARCH ACTIVITY AND BY REGION

REGION[1]	TYPE RESEARCH ACTIVITY[5]			
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION
	(THOUSAND DOLLARS)			
NORTHEAST	6415	398	656	528
EASTERN	3145	779	670	162
SOUTHEAST	1322	72	168	53
E.CENTRAL	2049	216	391	103
N.CENTRAL	2964	102	447	12
CENTRAL	1718	345	90	149
SOUTHWEST	1278	26	47	10
MOUNTAIN	755	78	78	0
WESTERN	3435	273	145	172
FOREIGN	717	50	202	96

TABLE 53. NUMBER OF RESEARCH PROJECTS BY TYPE OF RESEARCH ACTIVITY AND BY REGION

REGION[1]	TYPE RESEARCH ACTIVITY[5]			
	REQUIRE-MENTS	COMPOSI-TION	CONSUMP-TION	IMPLEMEN-TATION
NORTHEAST	193	22	22	12
EASTERN	96	19	15	8
SOUTHEAST	64	10	12	3
E.CENTRAL	96	16	17	3
N.CENTRAL	71	8	10	1
CENTRAL	66	11	10	3
SOUTHWEST	42	3	4	1
MOUNTAIN	33	4	5	0
WESTERN	118	13	8	4
FOREIGN	44	3	9	7

TABLE 54. TOTAL DOLLARS RESEARCH SUPPORT BY BIOLOGICAL MODEL AND BY REQUIREMENTS TYPE OF ACTIVITY SUBCATEGORIES

BIOLOGICAL MODEL [4]	REQUIREMENTS SUBCATEGORIES [8] DIGESTION-ABSORBTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
	(THOUSAND DOLLARS)					
HUMAN	735	4004	2893	1889	0	9521
ANIMAL	730	7335	1651	244	0	9960
TIS.&CELLS	88	799	230	0	0	1117
MICROORGAN	0	265	130	46	0	441
SUBCELL&CFB	30	489	307	74	18	918
POPULATION	56	27	30	1009	13	1135
UNCLASS.	26	576	76	28	0	706
TOTAL	1665	13415	5317	3290	31	23798

TABLE 55. NUMBERS OF RESEARCH PROJECTS BY BIOLOGICAL MODEL AND BY REQUIREMENTS TYPE OF ACTIVITY SUBCATEGORIES

BIOLOGICAL MODEL[4]	REQUIREMENTS SUBCATEGORIES[8] DIGESTION-ABSORBTION	METABOLISM -FUNCTION	NUTRIENTS REQUIRED	NUTRITION STATUS	UNCLASS	TOTAL
HUMAN	22	132	76	47	0	277
ANIMAL	30	299	60	11	0	400
TIS.&CELLS	4	31	8	0	0	43
MICROORGAN	0	10	2	1	0	13
SUBCEL&CFB	1	17	4	1	1	24
POPULATION	2	2	1	34	1	40
UNCLASS.	1	20	3	2	0	26
TOTAL	60	511	154	96	2	823

TABLE 56. TOTAL DOLLARS RESEARCH SUPPORT BY BIOLOGICAL MODEL AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF RESEARCH ACTIVITIES SUBCATEGORIES

BIOLOGICAL MODEL[4]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
HUMAN	0	40	774	814	209	210	418
ANIMAL	0	66	374	440	0	13	13
TIS.&CELLS	0	0	0	0	0	0	0
MICROORGAN	0	0	0	0	0	0	0
SUBCEL&CFB	0	103	26	129	0	12	12
POPULATION	153	163	846	1162	445	199	644
UNCLASS.	t	294	54	349	149	49	198
TOTAL	154	666	2074	2894	803	482	1285

[t]Less than $500.

TABLE 57. NUMBERS OF RESEARCH PROJECTS BY BIOLOGICAL MODEL AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF RESEARCH ACTIVITIES SUBCATEGORIES

BIOLOGICAL MODEL[4]	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]			*	IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL *	EDUCATION	INSTITU.	TOTAL
HUMAN	0	5	20	22	14	9	19
ANIMAL	0	4	18	20	0	1	1
TIS.&CELLS	0	0	0	0	0	0	0
MICROORGAN	0	0	0	0	0	0	0
SUBCEL&CFB	0	6	1	7	0	1	1
POPULATION	13	17	39	47	10	5	13
UNCLASS.	1	12	5	16	5	4	8
TOTAL	14	43	82	112	29	20	42

TABLE 58. TOTAL DOLLARS RESEARCH SUPPORT BY BIOLOGICAL MODEL AND BY TYPE OF AGENCY PERFORMING RESEARCH

TYPE AGENCY PERFORMING	BIOLOGICAL MODEL[4]						
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS
	(THOUSAND DOLLARS)						
UNIVERSITY	7098	7997	796	450	1147	1069	823
FED AGENCY	1592	1929	170	124	396	699	855
STA AGENCY	98	0	0	0	0	151	0
INDUSTRY	122	52	0	0	0	0	0
FOUNDATION	521	509	98	0	55	673	30
HOSPITAL	1453	729	66	0	4	406	7
OTHER	92	75	0	0	0	0	30

TABLE 59. NUMBER OF RESEARCH PROJECTS BY BIOLOGICAL MODEL AND BY TYPE OF AGENCY PERFORMING RESEARCH

TYPE AGENCY PERFORMING	BIOLOGICAL MODEL[4]						
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS
UNIVERSITY	191	327	33	11	39	59	37
FED AGENCY	34	40	5	3	8	10	17
STA AGENCY	2	0	0	0	0	2	0
INDUSTRY	5	3	0	0	0	0	0
FOUNDATION	16	20	3	0	2	6	2
HOSPITAL	42	27	2	0	1	4	1
OTHER	4	2	0	0	0	0	1

TABLE 60. TOTAL DOLLARS RESEARCH SUPPORT BY BIOLOGICAL MODEL AND BY TYPE OF AGENCY SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	BIOLOGICAL MODEL[4]						
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS
	(THOUSAND DOLLARS)						
USDA	784	1221	7	74	287	601	741
HEW	6473	6797	968	186	898	1534	672
NSF	27	264	0	7	58	4	0
AEC	49	20	20	0	0	0	0
DOD	1406	905	0	30	173	180	95
NASA	12	48	0	0	12	0	0
VA	720	880	120	0	0	80	0
OEO	725	0	0	0	0	418	0
OTHER FED	40	70	3	0	40	0	93
STATE GOV	332	791	2	77	133	142	103
UNIVERSITY	0	0	0	0	0	20	0
FOUNDATION	303	282	10	200	1	0	41
HOSPITAL	0	0	0	0	0	0	0
INDUSTRY	68	0	0	0	0	0	0
OTHER	37	13	0	0	0	19	0
TOTAL	10976	11291	1130	574	1602	2998	1745

TABLE 61. NUMBER OF RESEARCH PROJECTS BY BIOLOGICAL MODEL AND BY TYPE AGENCY SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	BIOLOGICAL MODEL[4]						
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- CF BIOCH	POPULA- TION	UNCLASS
USDA	37	71	1	4	16	28	26
HEW	149	248	37	8	23	31	21
NSF	1	13	0	1	3	1	0
ACE	2	1	1	0	0	0	0
DOD	38	21	0	1	5	4	3
NASA	1	5	0	0	1	0	0
VA	18	22	3	0	0	2	0
OEO	1	0	0	0	0	1	0
OTHER FED	1	3	1	0	1	0	2
STATE GOV	41	81	1	6	17	26	14
UNIVERSITY	0	0	0	0	0	1	0
FOUNDATION	32	32	1	1	1	0	5
HOSPITAL	0	0	0	0	0	0	0
INDUSTRY	2	0	0	0	0	0	0
OTHER	4	3	0	0	0	2	0
TOTAL	294	419	43	14	50	81	58

TABLE 62. TOTAL DOLLARS RESEARCH SUPPORT BY BIOLOGICAL MODEL AND BY REGION

REGION[1]	BIOLOGICAL MODEL[4]						
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- OF BIOCH	POPULA- TION	UNCLASS
	(THOUSAND DOLLARS)						
NORTHEAST	3088	2919	239	341	230	980	200
EASTERN	871	1862	179	124	323	589	808
SOUTHEAST	436	566	109	0	117	316	71
E.CENTRAL	992	1170	61	28	78	304	126
N.CENTRAL	2154	685	237	18	313	44	74
CENTRAL	715	1202	43	7	69	168	98
SOUTHWEST	562	433	19	18	171	44	114
MOUNTAIN	217	399	27	0	97	123	48
WESTERN	1344	1870	213	38	204	293	63
FOREIGN	597	185	3	0	0	137	143

TABLE 63. NUMBER OF RESEARCH PROJECTS BY BIOLOGICAL MODEL AND BY REGION

REGION[1]	BIOLOGICAL MODEL[4]						
	HUMAN	ANIMAL	TISSUE -CELLS	MICRO- ORGAN.	SUBCELL- OF BIOCH	POPULA- TION	UNCLASS
NORTHEAST	70	100	9	5	11	15	7
EASTERN	20	56	7	3	6	10	20
SOUTHEAST	23	33	4	0	6	10	3
E.CENTRAL	39	53	2	1	4	9	6
N.CENTRAL	24	28	9	2	6	6	3
CENTRAL	25	38	2	1	3	7	9
SOUTHWEST	19	18	1	1	3	3	1
MOUNTAIN	8	18	1	0	4	5	2
WESTERN	39	67	7	1	7	9	4
FOREIGN	27	8	1	0	0	7	3

TABLE 64. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF AGENCY PERFORMING RESEARCH BY REGION

REGION[1]	TYPE AGENCY PERFORMING RESEARCH							TOTAL
	UNIVERSITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	FOUNDATIONS	HOSPITAL	OTHER	
	(THOUSAND DOLLARS)							
NORTHEAST	5381	441	36	117	896	1063	63	7997
EASTERN	1196	3370	0	35	83	0	72	4756
SOUTHEAST	1534	0	0	0	20	42	19	1615
E.CENTRAL	1758	210	62	9	138	575	7	2759
N.CENTRAL	3296	0	0	t	106	123	0	3525
CENTRAL	1651	80	0	0	439	132	0	2302
SOUTHWEST	744	492	0	0	20	105	0	1361
MOUNTAIN	511	400	0	0	0	0	0	911
WESTERN	2943	423	151	0	177	331	0	4025
FOREIGN	366	349	0	13	7	294	36	1065

[t]Less than $500.

TABLE 65. NUMBER OF RESEARCH PROJECTS BY TYPE OF AGENCY PERFORMING RESEARCH BY REGION

REGION[1]	TYPE AGENCY PERFORMING RESEARCH							TOTAL
	UNIVERSITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	FOUNDATIONS	HOSPITAL	OTHER	
NORTHEAST	163	11	1	3	16	20	3	217
EASTERN	54	63	0	2	2	0	1	122
SOUTHEAST	75	0	0	0	1	2	1	79
E.CENTRAL	81	5	1	1	7	18	1	114
N.CENTRAL	69	0	0	1	4	4	0	78
CENTRAL	67	2	0	0	12	4	0	85
SOUTHWEST	31	11	0	0	1	3	0	46
MOUNTAIN	30	8	0	0	0	0	0	38
WESTERN	104	11	2	0	5	12	0	134
FOREIGN	23	6	0	1	1	14	1	46

TABLE 66. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF AGENCY SUPPORTING RESEARCH BY REGION

TYPE AGENCY SUPPORTING	REGIONS[1]									
	NE	E	SE	EC	NC	C	SW	M	W	F
	(THOUSAND DOLLARS)									
USDA	291	2249	294	180	120	160	20	97	206	98
HEW	5684	1856	994	1712	2262	1546	608	185	2236	445
NSF	127	10	18	23	22	32	0	0	118	10
AEC	69	0	20	0	0	0	0	0	0	0
DOD	668	282	50	75	50	0	555	520	248	341
NASA	12	3	13	0	0	0	12	0	32	0
VA	200	80	40	280	160	320	80	40	600	0
OEO	418	0	0	0	725	0	0	0	0	0
OTHER FED	0	59	0	1	3	18	0	0	131	34
STATE GOV	222	80	154	321	132	167	66	50	386	2
UNIVERSITY	0	0	0	0	0	0	0	0	0	20
FOUNDATION	296	137	25	125	39	54	5	19	60	77
HOSPITAL	0	0	0	0	0	0	0	0	0	0
INDUSTRY	0	0	0	34	0	0	0	0	0	34
OTHER	10	0	7	8	12	5	15	0	8	4
TOTAL	7997	4756	1615	2759	3525	2302	1361	911	4025	1065

TABLE 67. NUMBER OF RESEARCH PROJECTS BY TYPE OF AGENCY SUPPORTING RESEARCH BY REGION

TYPE AGENCY SUPPORTING	REGIONS[1]									
	NE	E	SE	EC	NC	C	SW	M	W	F
USDA	24	43	26	20	15	22	5	10	17	1
HEW	144	60	35	61	44	45	20	9	73	26
NSF	6	1	1	2	1	2	0	0	5	1
AEC	3	0	1	0	0	0	0	0	0	0
DOD	18	6	2	2	2	0	13	12	8	9
NASA	1	1	2	0	0	0	1	0	2	0
VA	5	2	1	7	4	8	2	1	15	0
OEO	1	0	0	0	1	0	0	0	0	0
OTHER FED	0	1	0	1	1	1	0	0	3	1
STATE GOV	21	12	24	29	24	21	9	11	34	1
UNIVERSITY	0	0	0	0	0	0	0	0	0	1
FOUNDATION	14	10	4	15	5	6	1	4	7	6
HOSPITAL	0	0	0	0	0	0	0	0	0	0
INDUSTRY	0	0	0	1	0	0	0	0	0	1
OTHER	1	0	1	1	2	1	1	0	1	1
TOTAL	217	122	79	114	78	85	46	38	134	46

TABLE 68. TOTAL DOLLARS RESEARCH SUPPORT BY REGION AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF ACTIVITIES SUBCATEGORIES

	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
REGION[1]	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
NORTHEAST	2	88	566	656	245	284	528
EASTERN	127	186	357	670	127	35	162
SOUTHEAST	9	56	104	168	50	3	53
E.CENTRAL	t	101	290	391	83	20	103
N.CENTRAL	5	3	439	447	0	12	12
CENTRAL	6	57	27	90	132	17	149
SOUTHWEST	1	16	30	47	0	10	10
MOUNTAIN	0	11	68	78	0	0	0
WESTERN	4	11	130	145	107	65	172
FOREIGN	0	138	64	202	59	38	96
TOTAL	154	666	2074	2894	803	482	1285

[t]Less than $500.

TABLE 69. NUMBERS OF RESEARCH PROJECTS BY REGION AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF ACTIVITIES SUBCATEGORIES

	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				* IMPLEMENTATION[10]		
REGION[1]	EXPEND.	PRACTICES	INTAKE	TOTAL	* EDUCATION	INSTITU.	TOTAL
NORTHEAST	2	4	20	22	8	7	12
EASTERN	3	7	10	15	6	3	8
SOUTHEAST	2	7	7	12	2	1	3
E.CENTRAL	1	10	10	17	3	2	3
N.CENTRAL	3	1	10	10	0	1	1
CENTRAL	1	7	3	10	2	1	3
SOUTHWEST	1	2	3	4	0	1	1
MOUNTAIN	0	2	5	5	0	0	0
WESTERN	1	1	8	8	3	1	4
FOREIGN	0	2	7	9	5	3	7
TOTAL	14	43	82	112	29	20	42

TABLE 70. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE OF AGENCY PERFORMING AND SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	TYPE AGENCY PERFORMING RESEARCH: UNIVERSITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	FOUNDATIONS	HOSPITAL	OTHER	TOTAL
	(THOUSAND DOLLARS)							
USDA	1377	2242	0	44	40	0	12	3715
HEW	13419	930	249	30	1304	1491	105	17528
NSF	338	0	0	0	0	22	0	360
AEC	89	0	0	0	0	0	0	89
DOD	660	1808	0	100	80	75	66	2789
NASA	60	12	0	0	0	0	0	72
VA	280	680	0	0	0	840	0	1800
OEO	725	0	0	0	418	0	0	1143
OTHER FED	153	93	0	0	0	0	0	246
STATE GOV	1566	0	0	0	0	0	14	1580
UNIVERSITY	20	0	0	0	0	0	0	20
FOUNDATION	625	0	0	0	43	169	0	837
HOSPITAL	0	0	0	0	0	0	0	0
INDUSTRY	0	0	0	0	0	68	0	68
OTHER	68	0	0	0	1	0	0	69
TOTAL	19380	5765	249	174	1886	2665	197	30316

TABLE 71. NUMBER OF RESEARCH PROJECTS BY TYPE OF AGENCY PERFORMING AND SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	TYPE AGENCY PERFORMING RESEARCH							TOTAL
	UNIVERSITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	DOUNDATIONS	HOSPITAL	OTHER	
USDA	148	29	0	3	2	0	1	183
HEW	414	31	4	2	34	29	3	517
NSF	17	0	0	0	0	2	0	19
AEC	4	0	0	0	0	0	0	4
DOD	22	39	0	2	4	3	2	72
NASA	6	1	0	0	0	0	0	7
VA	7	17	0	0	0	21	0	45
OEO	1	0	0	0	1	0	0	2
OTHER FED	6	2	0	0	0	0	0	8
STATE GOV	184	0	0	0	0	0	2	186
UNIVERSITY	1	0	0	0	0	0	0	1
FOUNDATION	45	0	0	0	7	20	0	72
HOSPITAL	0	0	0	0	0	0	0	0
INDUSTRY	0	0	0	0	0	2	0	2
OTHER	8	0	0	0	1	0	0	9
TOTAL	697	117	4	8	49	77	7	959

TABLE 72. AVERAGE DOLLARS RESEARCH SUPPORT PER PROJECT BY TYPE AGENCY PERFORMING AND SUPPORTING RESEARCH

TYPE AGENCY SUPPORTING	TYPE AGENCY PERFORMING RESEARCH							TOTAL
	UNIVERSITY	FEDERAL GOVERN	STATE GOVERN	INDUSTRY	FOUNDATIONS	HOSPITAL	OTHER	
	(THOUSAND DOLLARS)							
USDA	22	77	0	14	40	0	12	20
HEW	32	30	62	15	38	51	35	33
NSF	19	0	0	0	0	11	0	18
ACE	22	0	0	0	0	0	0	22
DOD	30	46	0	50	20	25	33	38
NASA	10	12	0	0	0	0	0	10
VA	40	40	0	0	0	40	0	40
OEO	725	0	0	0	418	0	0	571
OTHER FED	25	46	0	0	0	0	0	30
STATE GOV	8	0	0	0	0	0	7	8
UNIVERSITY	20	0	0	0	0	0	0	20
FOUNDATION	13	0	0	0	6	8	0	11
HOSPITAL	0	0	0	0	0	0	0	0
INDUSTRY	0	0	0	0	0	34	0	34
OTHER	8	0	0	0	1	0	0	7
TOTAL	27	49	62	22	38	34	28	32

TABLE 73. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE AGENCY SUPPORTING RESEARCH AND BY CONSUMPTION AND IMPLEMENTATION TYPE OF ACTIVITY SUBCATEGORIES

TYPE AGENCY SUPPORTING	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
USDA	142	286	306	734	118	54	172
HEW	0	117	1324	1441	306	50	356
NSF	0	6	41	47	14	0	14
AEC	0	0	0	0	0	0	0
DOD	t	45	170	216	58	103	161
NASA	0	0	0	0	0	0	0
VA	0	0	80	80	80	40	120
OEO	0	0	42	42	167	167	334
OTHER FED	0	93	0	93	0	40	40
STATE GOV	12	114	53	178	32	28	59
UNIVERSITY	0	0	20	0	0	0	0
FOUNDATION	0	5	20	25	28	0	28
HOSPITAL	0	0	0	0	0	0	0
INDUSTRY	0	0	0	0	0	0	0
OTHER	0	0	18	18	0	0	0
TOTAL	154	666	2074	2894	803	482	1285

[t]Less than $500.

TABLE 74. NUMBERS OF RESEARCH PROJECTS BY TYPE AGENCY SUPPORTING RESEARCH AND BY CONSUMPTION AND IMPLEMENTATION TYPE OF ACTIVITY SUBCATEGORIES

TYPE AGENCY SUPPORTING	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
USDA	9	27	22	40	4	6	10
HEW	0	5	31	35	6	2	8
NSF	0	1	2	2	1	0	1
AEC	0	0	0	0	0	0	0
DOD	1	4	10	10	5	7	9
NASA	0	0	0	0	0	0	0
VA	0	0	3	3	3	2	4
OEO	0	0	1	1	1	1	1
OTHER FED	0	2	0	2	0	1	1
STATE GOV	9	21	17	34	4	6	9
UNIVERSITY	0	0	1	1	0	0	0
FOUNDATION	0	2	6	7	5	1	5
HOSPITAL	0	0	0	0	0	0	0
INDUSTRY	0	0	0	0	0	0	0
OTHER	0	0	3	3	0	0	0
TOTAL	14	43	82	112	29	20	42

TABLE 75. TOTAL DOLLARS RESEARCH SUPPORT BY TYPE AGENCY PERFORMING RESEARCH AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF ACTIVITIES SUBCATEGORIES

TYPE AGENCY PERFORMING	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
	(THOUSAND DOLLARS)						
UNIVERSITY	27	308	999	1334	96	109	205
FED AGENCY	127	340	450	917	175	156	331
STA AGENCY	0	0	0	0	129	0	129
INDUSTRY	0	0	0	0	0	0	0
FOUNDATION	0	1	112	112	302	168	470
HOSPITAL	0	15	513	528	70	20	90
OTHER	0	3	0	3	30	30	60
TOTAL	154	666	2074	2894	803	482	1285

TABLE 76. NUMBERS OF RESEARCH PROJECTS BY TYPE AGENCY PERFORMING RESEARCH AND BY CONSUMPTION AND IMPLEMENTATION TYPES OF ACTIVITIES SUBCATEGORIES

TYPE AGENCY PERFORMING	TYPE RESEARCH ACTIVITY SUBCATEGORIES						
	CONSUMPTION[9]				IMPLEMENTATION[10]		
	EXPEND.	PRACTICES	INTAKE	TOTAL	EDUCATION	INSTITU.	TOTAL
UNIVERSITY	11	29	50	73	9	6	14
FED AGENCY	3	10	16	20	8	10	14
STA AGENCY	0	0	0	0	2	0	2
INDUSTRY	0	0	0	0	0	0	0
FOUNDATION	0	1	6	6	5	2	5
HOSPITAL	0	3	10	12	4	1	5
OTHER	0	1	0	1	1	1	2
TOTAL	14	43	82	112	29	20	42

An Evaluation of Research in the United States on

HUMAN NUTRITION

Report No. 2
Benefits from Nutrition Research

Prepared by
A JOINT TASK GROUP OF THE
U.S. DEPARTMENT OF AGRICULTURE
AND THE STATE UNIVERSITIES
AND LAND GRANT COLLEGES

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This report is part of a study conducted at the direction of the Agricultural Research Policy Advisory Committee, U.S. Department of Agriculture. A joint task group representing the State Agricultural Experiment Stations and the U.S. Department of Agriculture was assigned the responsibility for making the study. Task group members were:

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CONTENTS

Tables

Figures

PREFACE

This Report is No. 2 in a series on evaluation of human nutrition research. It addresses itself to reviewing the current situation with respect to each nutrition-related health problem. The first sixteen pages summarize the estimated magnitude of potential benefits from nutrition research on these problems.

Estimates of potential savings are judgments based on review of scientific literature and discussions with clinicians. No claim is made that all the benefits are included or that the claims made for nutrition's contribution to the problems are as great or small as eventually may be realized. At best, they are subjective evaluations, because basic data do not exist.

The balance of Report No. 2 provides a concise review of background data concerning the magnitude of each nutrition-related health problem, geographical and population differences in the severity of the problem, and possible causal factors, including the known and suggestive nutrition relationships.

This evaluation of Human Nutrition Research in the United States has dual purposes, each with its own objectives.

One purpose of this study is to conduct an evaluative analysis of current problems related to human nutrition and to present the results of this analysis in a meaningful manner that will facilitate policy decisions about future programs of research on food and human nutrition topics. The specific objectives of this phase of the study are:

1. To appraise the current nutritional status of the population and associated nutrition-related problems.

2. To describe and evaluate what is currently known about corrective measures for nutrition-related problems.

3. To inventory and describe the current research that is contributing new knowledge to the correction of nutrition-related problems.

4. To identify the inadequacies in current and new knowledge relevant to nutrition-related problems and to propose research designed to remove these inadequacies.

The second purpose of the study is to determine the feasibility of applying cost-benefit analysis to the evaluation of research programs in the particular circumstances encountered in public research administration. The specific objectives of this phase of the study are:

1. To develop a generalized framework of analysis that could be reapplied to topical areas other than the specific one studied in this pilot effort.

2. To develop quantification and evaluative techniques useful to public research administration.

3. To evaluate the feasibility and potential usefulness of such techniques of analysis as standard procedures for research administration in the U.S. Department of Agriculture.

The basic approach to achieving the dual purposes of this study is to identify the extent of human nutrition and food oriented health problems that currently exist, determine what could be done with existing nutrition knowledge, and as a residual specify what additional new knowledge must be generated to permit alleviation of these problems.

Report No. 1 is a survey of human nutrition research that is currently being supported and/or conducted by Public Research Organizations. It provides detailed information classified according to many useful ways of looking at human nutrition research, including nutrition-related health problems.

Report No. 2 is concerned with the current situation with respect to each problem and estimates the potential benefits from application of new knowledge. Report No. 3, to be issued, will review the state of the art of our nutrition knowledge.

It is planned to use these reports as basic documents for expert panels to react to in a modified Delphi oracle technique to improve subjective estimates of potential benefits, determine needed research, and estimate the resources required to reach research objectives. Similarly, an expert panel would be asked to determine the priorities for needed research.

The results of these subjective evaluations, together with a more complete description of the study plan and methodology, will be covered in a final report.

BENEFITS FROM NUTRITION RESEARCH

Better health, a longer active lifespan, and greater satisfaction from work, family and leisure time are among the benefits to be obtained from improved diets and nutrition. Advances in nutrition knowledge and its application during recent decades have played a major role in reducing the number of infant and maternal deaths, deaths from infectious diseases, particularly among children, and in extending the productive lifespan and life expectancy. Significant benefits are possible both from new knowledge of nutrient and food needs and from more complete application of existing knowledge. The nature and magnitude of these benefits is estimated in Table 1. Potential benefits may accrue from alleviating nutrition-related health problems, from increased individual performance and satisfactions and increased efficiency in food services. A vast reservoir of health and economical benefits can be made available by research yet to be done on human nutrition.

Major health problems are diet related. Most all of the health problems underlying the leading causes of death in the United States (Fig. 1) could be modified by improvements in diet. The relationship of diet to these health problems and others is discussed in greater detail later in this report. Death rates for many of these conditions are higher in the U. S. than in other countries of comparable economic development. Expenditures for health care in the U. S. are skyrocketing, accounting for 67.2 billion dollars in 1970--or 7.0 percent of the entire U. S. gross national product.

The real potential from improved diet is preventive. Existing evidence is inadequate for estimating potential benefits from improved diets in terms of health. Most nutritionists and clinicians feel that the real potential from improved diet is preventative in that it may defer or modify the development of a disease state so that a clinical condition does not develop. The major research thrust, nationwide, has been on the role of diet in treating health problems after they have developed. This approach has had limited success. USDA research emphasis has been placed on food needs of normal, healthy persons and findings from this work have contributed much of the existing knowledge on their dietary requirements.

Benefits would be shared by all. Benefits from better nutrition, made possible by improved diets, would be available to the entire population. Each age, sex, ethnic, economic, and geographic segment would be benefited. The lower economic and nonwhite population groups would benefit most from effective application of current knowledge.

These savings are only a small part of what might be accomplished for the entire population from research yet to be done. Some of the improvements can be expressed as dollar benefits to individuals or to the nation. The social and personal benefits are harder to quantify and describe. It is difficult to place a dollar figure on the avoidance of pain or the loss of a family member; satisfactions from healthy, emotionally adjusted families; career achievement; and the opportunity to enjoy leisure time.

Major health benefits are long range. Predictions of the extent to which diet may be involved in the development of various health problems have been based on current knowledge of metabolic pathways of nutrients, but primarily of abnormal metabolic pathways developed by persons in advanced stages of disease. There is little understanding of when or why these metabolic changes take place. The human body is a complex and very adaptive mechanism. For most essential metabolic processes alternate pathways exist which can be utilized in response to physiological, diet, or other stress. Frequently, a series of adjustments take place and the ultimate result does not become apparent for a long time, even years, when a metabolite such as cholesterol accumulates. Early adjustment of diet could prevent the development of undesirable long-range effects. Minor changes in diet and food habits instituted at an early age might well avoid the need for major changes, difficult to adopt later in life.

Regional differences in diet related problems. The existence of regional differences in the incidence of health problems has been generally recognized and a wide variation in death rates still exists among geographic areas (Figs. 2,3). These differences in death rate may reflect the cumulative effect of chronic low intake levels of some nutrients throughout the lifespan and by successive generations. A number of examples of regional health problems attributable to differences in the nutrient content of food or to dietary pattern could be given. Perhaps the best known is "the goiter belt" where soils and plants were low in iodine and the high incidence and death rate of goiter was reduced when the diet was supplemented with iodine. Another situation existed in some of the southern states where pellagra was a scourge a few decades ago. Corn was the major food protein source for low income families in these areas. The resulting niacin deficiency raised the incidence of pellagra to epidemic proportions.

Migration from the high death rate areas almost always results in a reduction in the death rate, although the improvement never approaches the level achieved by those who were born and continued to live in the low rate areas (Fig. 4). Similarly, persons who move from low rate areas into higher rate areas lose part of the advantage. If the death

rate for one of the high death rate areas, Wilkes Barre, Pennsylvania, were applied to the entire U. S. population, 140,489 more persons under 65 years would have died per year during the period 1959-61 (Table 2). If the death rate for one of the lower rate areas, Nebraska, had prevailed, there would have been 131,634 fewer deaths. The highest death rate areas generally correspond to those where agriculturists have recognized the soil as being depleted for several years. This suggests a possible relationship between submarginal diets and health of succeeding generations.

TABLE 1

Magnitude of benefits from nutrition research

PART A. Nutrition related health problems

Health problem	Magnitude of loss	Potential savings from improved diet
Heart and vasculatory	Over 1,000,000 deaths in 1967	
	Over 5 million people with definite or suspect heart disease in 1960-62	25% reduction
	$31.6 billion in 1962	20% reduction
Respiratory and infectious	82,000 deaths per year	
	246 million incidents in 1967	20% fewer incidents
	141 million work days lost in 1965-66	15-20% fewer days lost
	166 million school days lost	15-20% fewer days lost
	$5 million in medical and hospital costs	$1 million
	$1 billion in cold remedies and tissues	$20 million
Mental health	2.5% of population of 5.2 million people are severely or totally disabled. 25 million people have manifest disability	10% fewer disabilities

TABLE 1

PART A. Nutrition related health problems (cont.)

Health problem	Magnitude of loss	Potential savings from improved diet
Infant mortality and reproduction	Infant deaths in 1967--79,000	50% fewer deaths
	Infant death rate 22.4 per 1,000	50% fewer deaths
	Fetal death rate 15.6 per 1,000	50% fewer deaths
	Maternal death rate 28.0 per 100,000 live births	50% fewer deaths
	Child death rate (1-4 yrs.) 96.1 per 100,000 in 1964	Reduce rate to 10 per 100,000
	15 million with congenital birth defects	3 million fewer children with birth defects
Early aging and lifespan	49.1% of population, about 102 million people have one or more chronic impairments	10 million people without impairments
	People surviving to age 65:	1% improvement per year to 90% surviving
	White males -- 66%	
	Negro males -- 50%	
	White females -- 81%	
	Negro females -- 64%	
	Life expectancy in years:	Bring Negro expectancy up to White
	White males -- 67.8	
	Negro males -- 61.1	
	White females -- 75.1	
	Negro females -- 68.2	

TABLE 1

PART A. Nutrition related health problems (cont.)

Health problem	Magnitude of loss	Potential savings from improved diet
Arthritis	16 million people afflicted 27 million work days lost 500,000 people unemployed Annual cost $3.6 billion	8 million people without afflictions 13.5 million work days 125,000 people employed $900 million per year
Dental health	44 million with gingivitis 23 million with advanced periodontal disease $6.5 billion public and private expenditures on dentists' services in 1967 22 million edentulous persons (1 in 8) in 1957 1/2 of all people over 55 have no teeth	50% reduction in incidence, severity and expenditures
Diabetes and carbohydrate disorders	3.9 million overt diabetic 35,000 deaths in 1967 79% of people over 55 with impaired glucose tolerance	50% of cases avoided or improved

TABLE 1

PART A. Nutrition related health problems (cont.)

Health problem	Magnitude of loss	Potential savings from improved diet
Osteoporosis	4 million severe cases 25% of women over 40	75% reduction
Obesity	3 million adolescents 30 to 40% of adults 60 to 70% over 40 years	80% reduction in incidence
Anemia and other nutrient deficiencies	See Improved Work Efficiency, Growth and Development, and Learning Ability	
Alcoholism	5 million alcoholics; 1/2 are addicted About 24,500 deaths in 1967 caused by alcohol Annual loss over $2 billion from absenteeism, lowered production and accidents	33% 33% 33%

TABLE 1

PART A. Nutrition related health problems (cont.)

Health problem	Magnitude of loss	Potential savings from improved diet
Eyesight	48.1%, or 86 million people over 3 years wore corrective lenses in 1966 81,000 become blind every year $103 million in welfare	20% fewer people blind or with corrective lenses
Cosmetic	10% of women ages 9 or more with vitamin intakes below recommended daily allowances	
Allergies	22 million people (9%) are allergic 16 million with hayfever asthma 7-15 million people (3-6%) allergic to milk Over 693 thousand persons (1 in 3,000) allergic to gluten	20% people relieved 90% people relieved 90% people relieved
Digestive	8,495 thousand work days lost 5,013 thousand school days lost About 20 million incidents of acute condition annually $4.2 billion annual cost 14 million persons with duodenal ulcers $5 million annual cost 4,000 new cases each day	25% fewer acute conditions Over $1 billion in costs

TABLE 1

PART A. Nutrition related health problems (cont.)

Health problem	Magnitude of loss	Potential savings from improved diet
Kidney and urinary	55,000 deaths from renal failure 200,000 with kidney stones	20% reduction in deaths and acute conditions
Muscular disorders	200,000 cases	10% reduction in cases
Cancer	600,000 persons developed cancer in 1968 320,000 persons died of cancer in 1968	20% reduction in incidence and deaths

TABLE 1

PART B. Individual satisfactions increased

Satisfactions	Magnitude of loss	Potential savings from improved diet
Improved work efficiency		0.5% increase in on the job productivity
Improved growth and development	113,000 deaths from accident 324.5 million work days lost 51.8 million people needing medical attention and/or restricted activity	25% fewer deaths and work days lost
Improved learning ability	Over 6.5 million mentally retarded persons with I.Q. below 70 12% of school age children need special education	Raise I.Q. by 10 points for persons with I.Q. 70-80

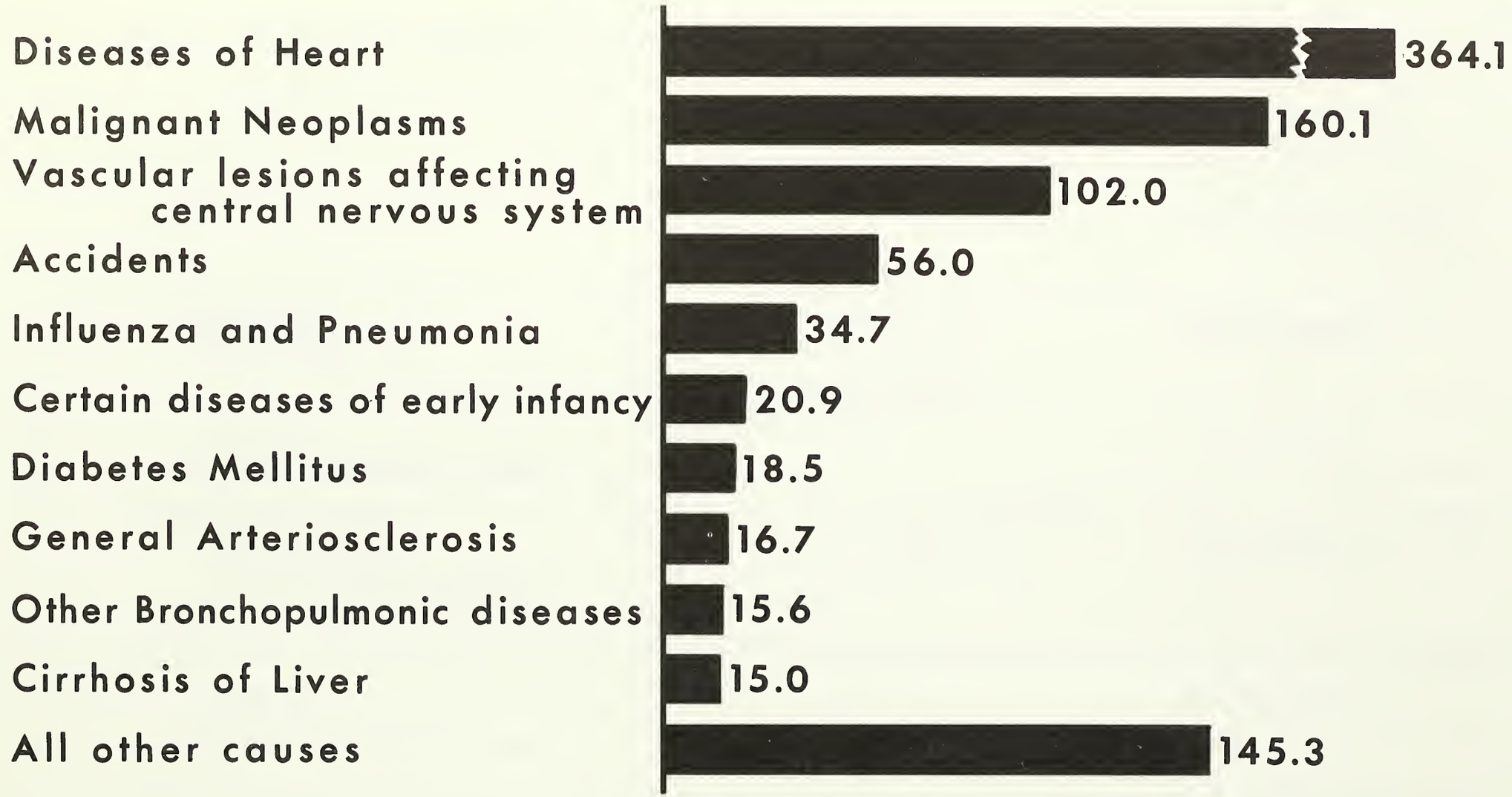
TABLE 1

PART C. Increased efficiency in food services

Efficiency	Magnitude of loss	Potential savings from improved diet
Improved efficiency in food preparation and menu planning		Not estimated
Reduced losses of nutrients in food storage, handling, and preparation		Not estimated
Improved efficiency in food selection		Not estimated
Improved efficiency in food programs		Not estimated

LEADING CAUSES OF DEATH

Rates per 100,000, U.S. 1969



SOURCE: BUREAU OF THE CENSUS

Figure 1

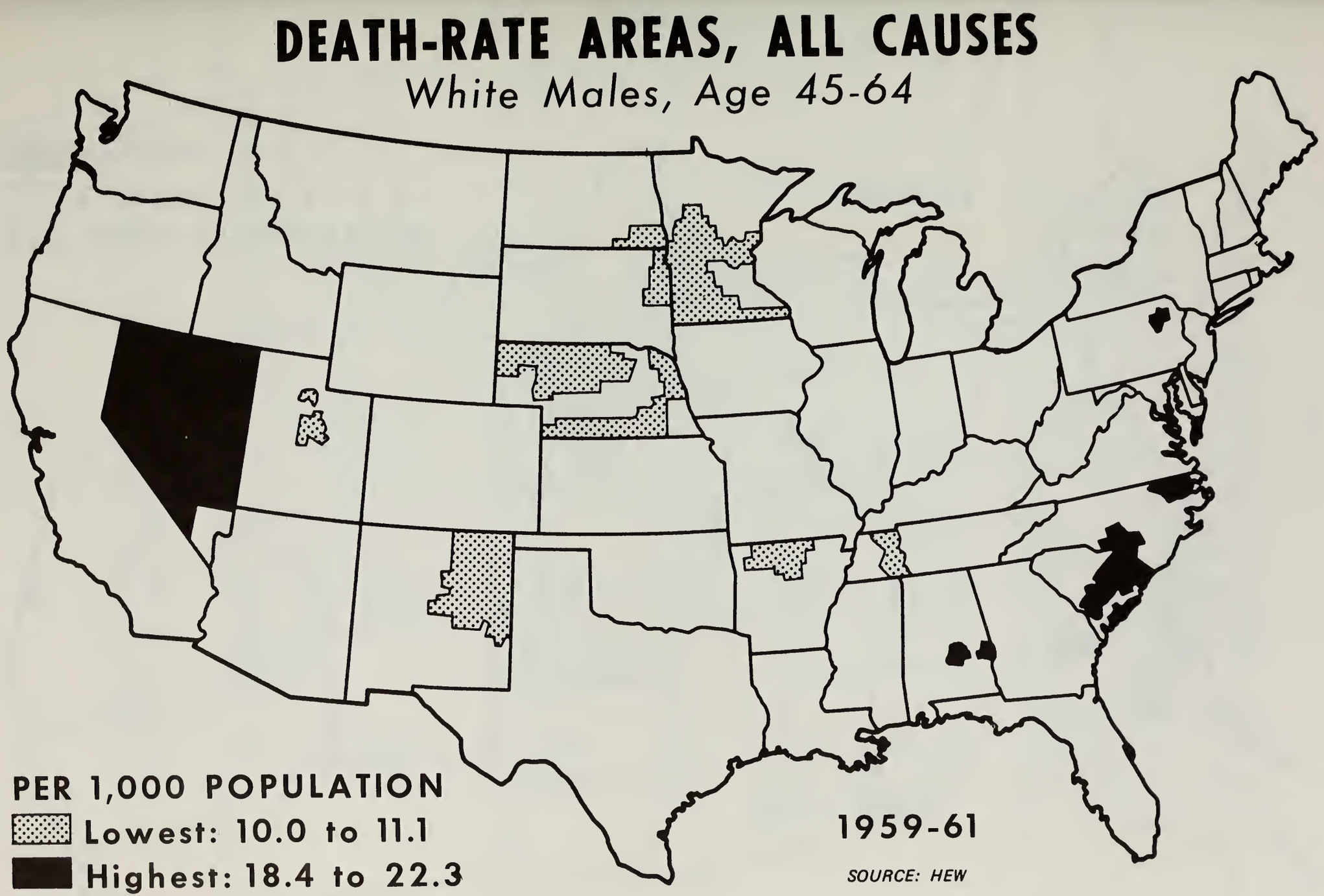

DEATH-RATE AREAS, ALL CAUSES
White Males, Age 45-64
PER 1,000 POPULATION
Lowest: 10.0 to 11.1
Highest: 18.4 to 22.3
1959-61
SOURCE: HEW

Figure 2

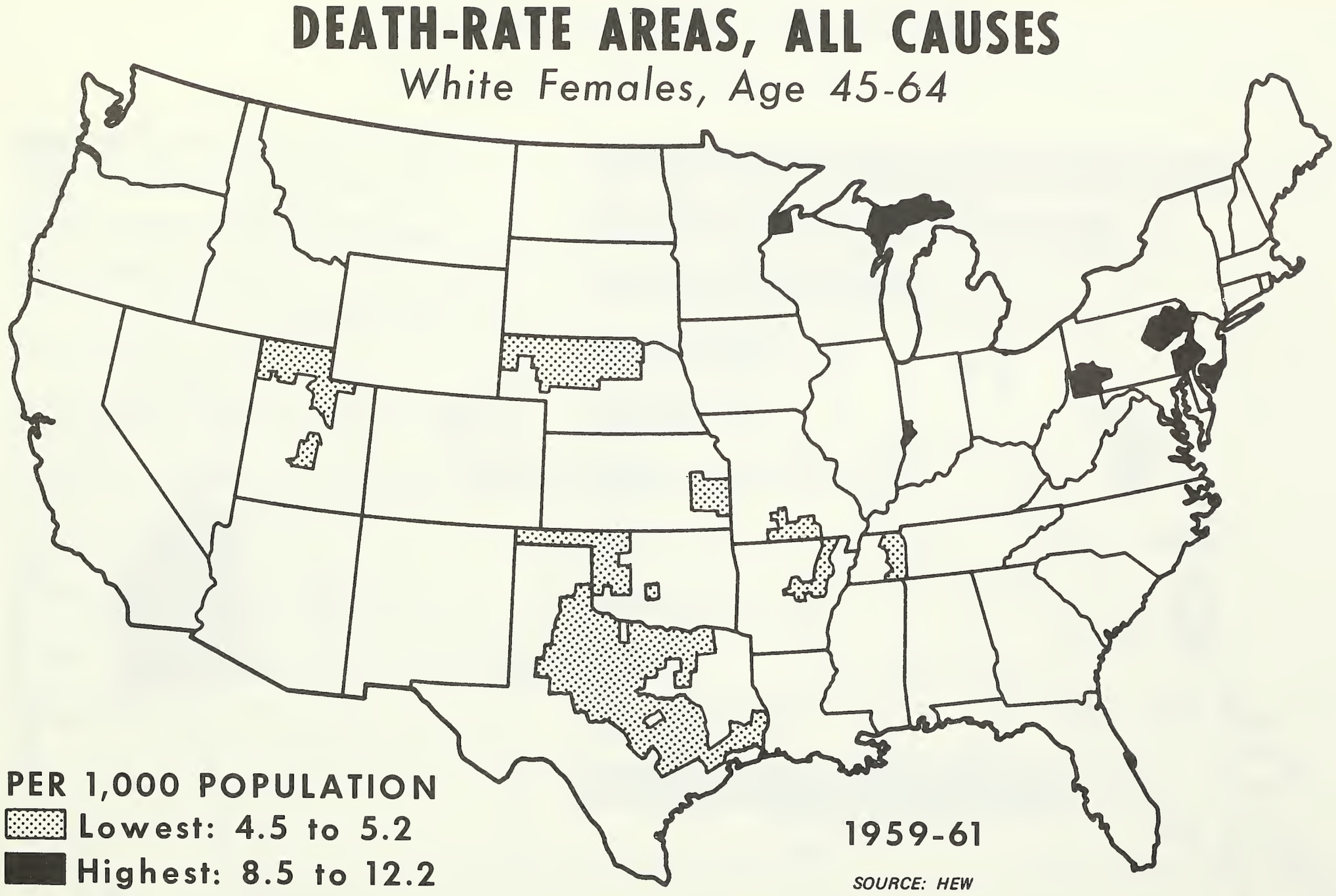

DEATH-RATE AREAS, ALL CAUSES
White Females, Age 45-64
PER 1,000 POPULATION
Lowest: 4.5 to 5.2
Highest: 8.5 to 12.2
1959-61
SOURCE: HEW

Figure 3

TABLE 2

Difference in average annual number of deaths in the United States under different assumptions, whites under 75 years, 1959-1961

Age and sex	If instead of the actual United States experience, the death rates for specified areas for 1959-1961 applied: Four lowest economic subregions of 1949-51	Nebraska State economic area 5	Minnesota State economic area 5	Wilkes-Barre, (Luzerne County) Pennsylvania
Under 35[1]				
Male	-1298	-9082	-6925	+2959
Female	-753	-8874	-5058	+1067
35-44				
Male	-4044	-6863	-5597	+8442
Female	-3672	-4541	-2035	+3786
45-54				
Male	-18813	-25785	-21627	+32236
Female	-10333	-8722	-12365	+5025
55-64				
Male	-43082	-49343	-45144	+56706
Female	-14900	-18424	-12831	+30268
Total under 65	-96895	-131634	-111584	+140489
65-74				
Male	-47196	-45802	-48334	+92040
Female	-20049	-23387	-29510	+72185
Total under 75	-164140	-200823	-189428	+304714

[1]Calculated from crude death rates under 35 years of age, age adjusted to the U. S. in 1960 by age groups under 1, 1-4, 5-14, 15-24, and 25-34.

Source: Sauer, H. I., and D. M. Moore 1966 Area and Migration Differences in the Risk of Dying. Amer. Publ. Health Ass. Meeting, Nov. 2.

Heart and vasculatory diseases are the number one cause of deaths in the U. S., accounting for about 54 percent of all deaths; ranging from one-tenth of all deaths under the age of 35 years, and one-third between 35 and 45 years, to 71 percent at age 75 years and above (Fig. 4). There were over one million deaths from heart and vasculatory disease in 1967. The way the incidence of heart disease is rising, more than 1.5 million Americans can be expected to suffer heart attacks and strokes in 1970. This projection was made in 1967 by a group of heart experts at an International Conference on Thrombosis sponsored by the National Academy of Sciences.

The most recent figures for incidence of heart and vasculatory diseases are from the Health Survey of 1960-62 (Table 3). At that time, definite heart disease had been diagnosed in 13.2 percent of the population and was suspected in an additional 11.7 percent. During 1960-62, there were 28 million adults between 18 and 79 years of age diagnosed or suspected of having heart disease. The condition is more frequently found in men than in women before the menopause and is much more prevalent in Negroes than whites (Table 4). The President's Commission on Heart Disease, Cancer, and Stroke estimated economic costs of deaths from heart disease at $31.9 billion in 1962.

Although the percent of all deaths due to the cardiovascular diseases has increased continuously since 1900, the death rate from cardiovascular diseases has gone down (Figs. 5,6). In 1900 cardiovascular diseases accounted for 20 percent of all deaths. Today, more than half of all deaths are from this cause. Meanwhile, in the age groups below 45 years, the death rates have gone down for both males and females. In the 45-64 age group, the death rate among females has gone down steadily since 1930. In men of the same group, the trend was upward until about 1940, plateaued for a period, and then started downward about 1950. Since then it has dropped about 7.5 percent. In the age group 65 and over, the rates have been relatively stable. However, if adjustment were made for the increasing proportion of older people in this age group, the trend would be somewhat downward.

Death rates from heart disease are much higher in the U. S. than in many other countries of comparable economic level (Table 5). Among the developed countries, 26 have lower death rates from heart disease than the U. S. The rates of death range from 51.8 per 100,000 population in Japan, and 79.8 in France, to 312.9 in the United States, 344.5 in West Berlin, and 352.3 in Scotland.

Epidemiological data indicate a high variance in death rate from heart and vascular disease among geographic areas in the U. S. (Figs. 7,8,9,10). Highest rates for white males were in the Southeast, for white females in the Southeast and Upper Michigan. The effects of early environment, including diet, is apparent in the statistics. Persons born in areas where the cardiovascular mortality was high, were more likely to die from this cause even though they moved to low rate areas. However, their chances were better than if they remained in their state of birth. Persons from low rate areas fared best if they remained in their birth place. Those who moved to high rate areas were less likely to die of heart disease than those who were born and lived in the high rate area.

Any consideration of the reasons underlying geographic differences in death rate must include diet. What foods are eaten? Do the foods differ in nutrient content or value among the areas? What differences exist in the mineral content of the water supply? Areas with the highest death rate for men are those recognized as having depleted soils. Higher death rates from cardiovascular disease also are found in areas where the water is hard.

The cause of the high death rate from heart disease in the U. S. is not known. Several high risk factors have been identified including family history, sex, age, smoking, stress, blood pressure, diabetes, overweight, lack of exercise, blood cholesterol, blood triglycerides (Figs. 11,12,13). The importance of diet compared to the other risk factors is not known. A great deal of attention has been given to the possible relationship between diet and heart disease because most of the conditions are associated with an alteration in fat metabolism, reflected in increased levels of blood cholesterol and/or blood triglycerides. Fat transport systems are not normal in many cardiovascular patients; five types of hyperlipoproteinemia have been identified and diets devised to control the conditions. The diets vary for each of the five types and involve control of calories, cholesterol, type, and amount of fat or carbohydrate.

Substantive data have not been obtained on the role of diet prior to or during the development of cardiovascular problems. Overweight is a problem because of the frequent association with high blood pressure and diabetes. In addition, additional body mass puts an added weight on the heart. The relationship between high blood sugar levels and stroke is clearly established although the reason is not. Depending on the individual, the blood cholesterol level may be reduced by one or more of these dietary changes; reduction in the amount of fat, increasing the proportion of fat occurring as polyunsaturated fatty acids, or changing the type of carbohydrate. Very likely other nutrients can and do exert an effect. For example, an increased intake of chromium may increase the glucose tolerance of many individuals and thus might reduce the risk of heart disease for some persons.

A number of studies have been made on the relationship of diet and diet adjustment to the incidence of cardiovascular disease in selected populations. None of these has been conclusive. While diet may alter the risk factors, there is no clear statistical proof that the development of coronary heart disease can be slowed up by changing diet. There is no proof that lowering the dietary cholesterol intake affects the coronary patient. Scientists do not agree on the value of diet adjustment in preventing death in coronary patients. A number of diet studies have been of men who had suffered heart attacks. Coronary relapses were usually 25-50 percent less among those men on diets adjusted to reduce the intake of fat and cholesterol and to increase the proportion of polyunsaturated fatty acids. However, there was no difference in the total number of deaths. Interpretation of the results is complicated by the fact that adherence to the diets was only 50 percent.

There is no proof, but considerable evidence, that to be effective, any change in dietary patterns should begin at an early age in order to delay the onset of these diseases. The first changes in the vascular system may have occurred by the age of three, although coronary heart disease may not be diagnosed until the fourth or fifth decade. Good nutrition, including control of weight and diabetes by those having a family history of heart disease, should be encouraged from birth.

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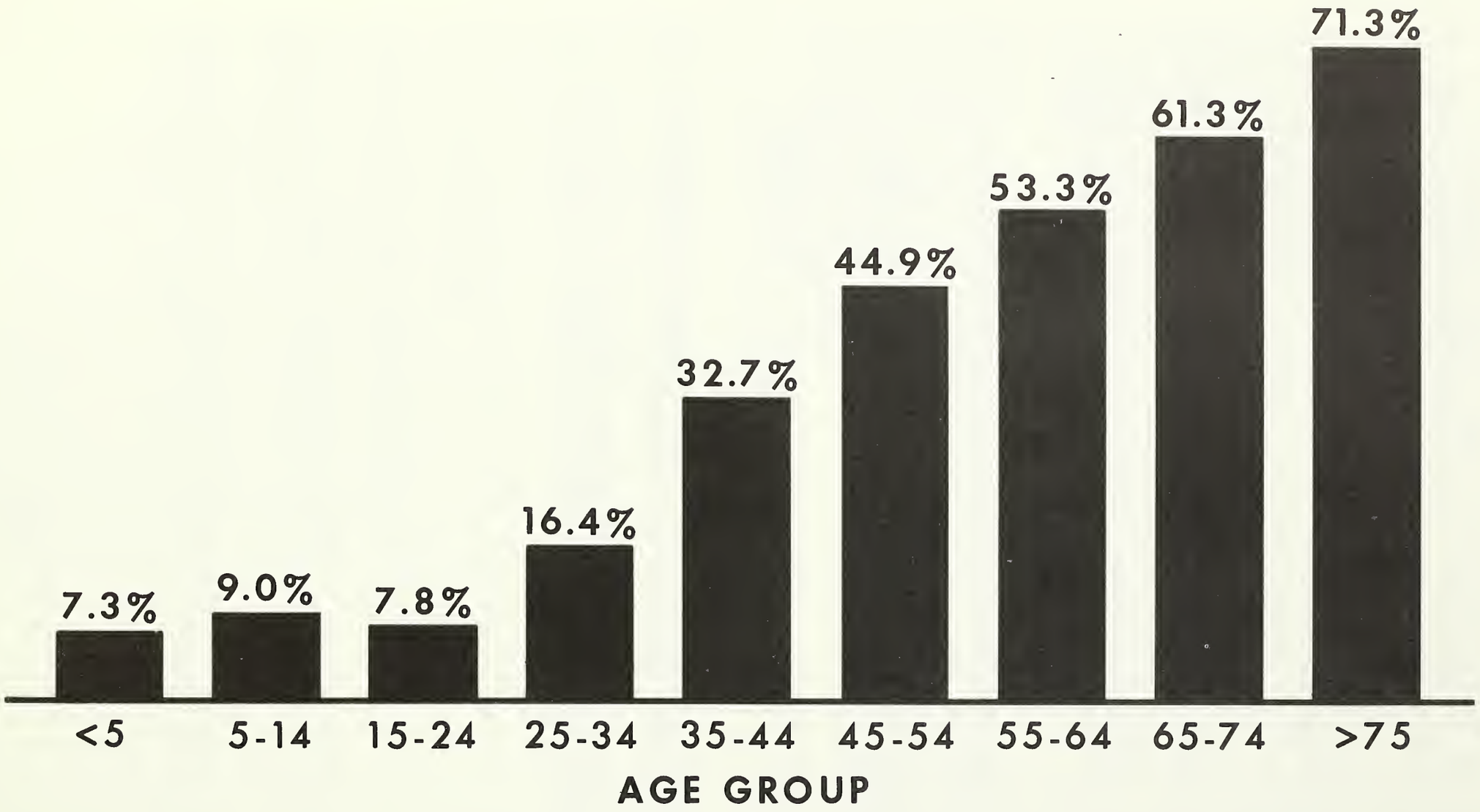
DEATHS DUE TO CARDIOVASCULAR DISEASES-1962



AS A PERCENT OF ALL DEATHS

SOURCE: HEW

Figure 4

TABLE 3

Incidence of heart disease in adults, 1960-1962

	Number of adults (1,000)	Percent of all adults
Definite cases	14621	13.2
Male	6652	12.6
Female	7970	13.7
Suspect cases	12979	11.7
Male	7315	13.9
Female	5663	9.7

Heart and vascular problems cause 54 percent of all deaths in the United States.

Source: National Center for Health Statistics 1964 PHS Publ. 1000, series 11, no. 6. U. S. Dept. of Health, Education, and Welfare.

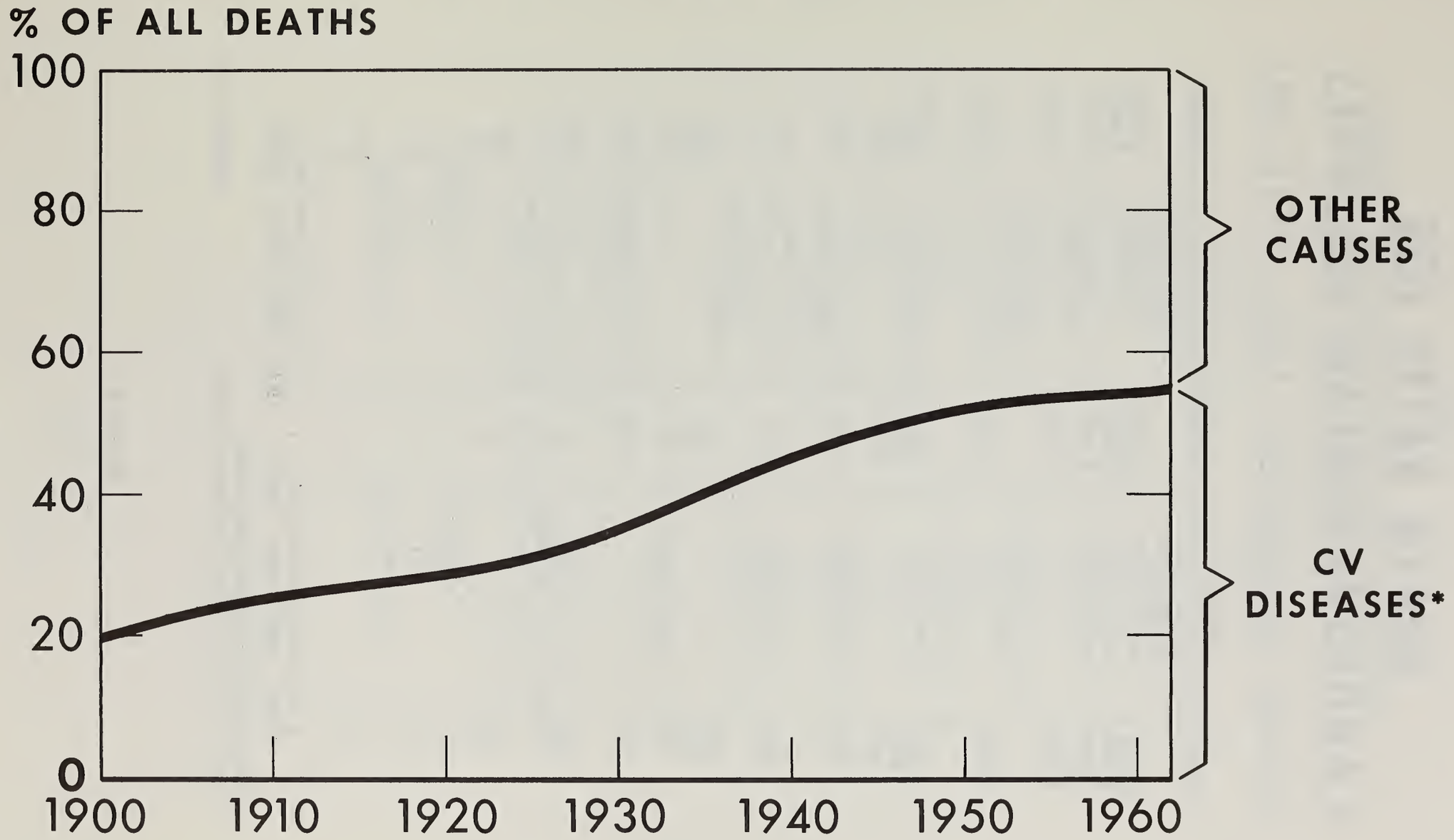
TABLE 4

Prevalence of definite and suspect heart disease for white and Negro adults, by age and sex: United States, 1960-1962

Age	Men		Women	
	White	Negro	White	Negro
	Percent of specified population group			
Definite heart disease				
Total 18-79 years	11.5	23.8	12.5	24.8
18-24 years	1.4	1.9	0.8	3.2
25-34 years	2.5	7.9	1.4	6.8
35-44 years	6.1	18.1	4.9	14.0
45-54 years	11.3	33.0	9.6	36.6
55-64 years	22.5	41.6	23.7	52.2
65-74 years	31.3	56.9	43.5	70.1
75-79 years	39.3	32.3	44.8	69.5
Suspect heart disease				
Total 18-79 years	13.5	17.6	9.3	12.6
18-24 years	6.3	6.7	1.2	8.3
25-34 years	5.5	16.9	2.6	7.8
35-44 years	10.6	16.7	5.4	13.0
45-54 years	18.4	18.2	11.8	14.8
55-64 years	17.6	28.2	20.3	20.3
65-74 years	26.4	11.9	17.3	16.2
75-79 years	25.3	50.3	23.4	14.2

Source: National Center for Health Statistics 1964 PHS Publ. 1000, series 11, no. 6. U. S. Dept. of Health, Education, and Welfare.

DEATHS DUE TO CARDIOVASCULAR DISEASES



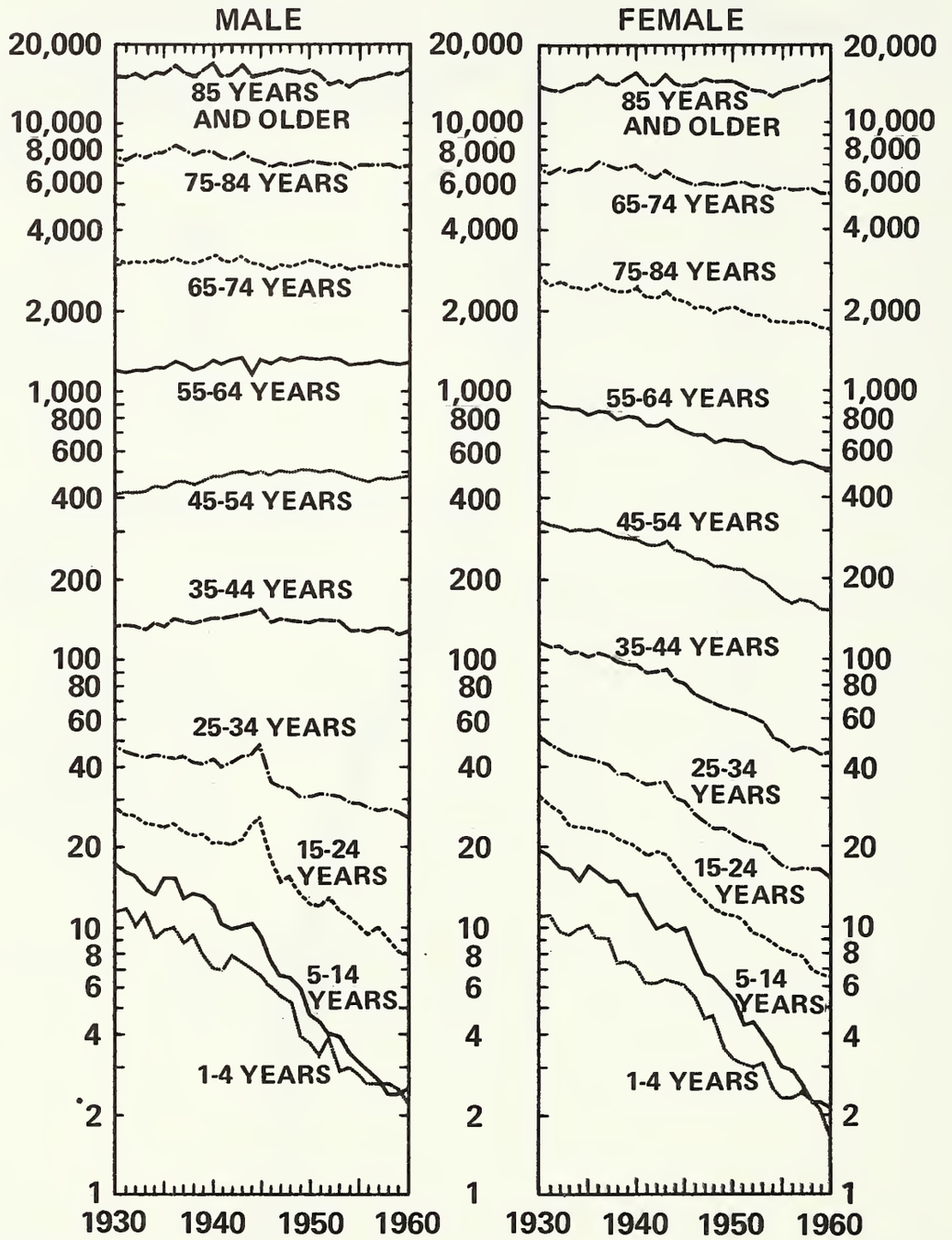
*CARDIOVASCULAR DEATHS INCLUDE THOSE FROM CHRONIC NEPHRITIS.

SOURCE: HEW

Figure 5. — In 1900 CV diseases accounted for 20 percent of all deaths. Today more than half of all deaths are due to CV diseases. Part of this increase is due to the larger proportion of older people in the population. It is in the older age groups that CV diseases take their greatest toll.

DEATH RATES FOR CARDIOVASCULAR DISEASES

White Population, U.S., 1930–60



DEATH RATES PER 100,000 POPULATION FOR MAJOR CARDIOVASCULAR-RENAL DISEASES.

SOURCE: HEW

Figure 6

TABLE 5

Deaths from arteriosclerotic and degenerative heart disease per 100,000 population in selected countries, 1963 or 1964

Country	Death rate
Netherlands	182.1
Norway	263.5
Sweden	298.0
Iceland	171.8
Denmark	263.2
Israel (1)	154.4
Switzerland	242.2
New Zealand	256.1
Ireland	299.6
France	79.8
England & Wales	306.8
Japan	51.8
Czechoslovakia	157.3
West Germany (2)	210.4
Australia	286.2
United States	312.9
Scotland	352.3

(1) Jewish population only
(2) Including West Berlin

Source: United Nations 1966 Demographic Yearbook 1965. United Nations, New York.

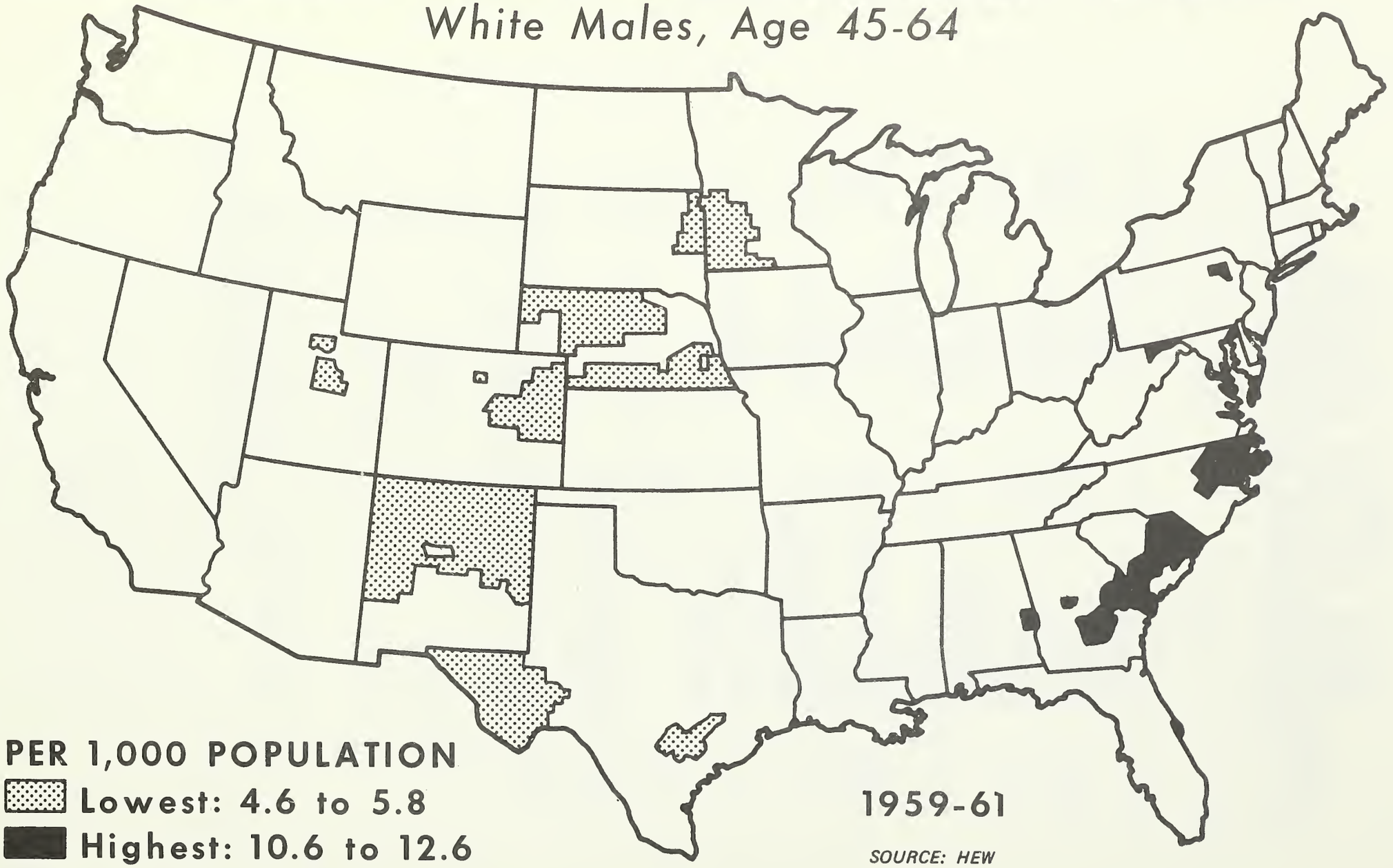

DEATH-RATE AREAS, CARDIOVASCULAR DISEASES
White Males, Age 45-64
PER 1,000 POPULATION
Lowest: 4.6 to 5.8
Highest: 10.6 to 12.6
1959-61
SOURCE: HEW

Figure 7

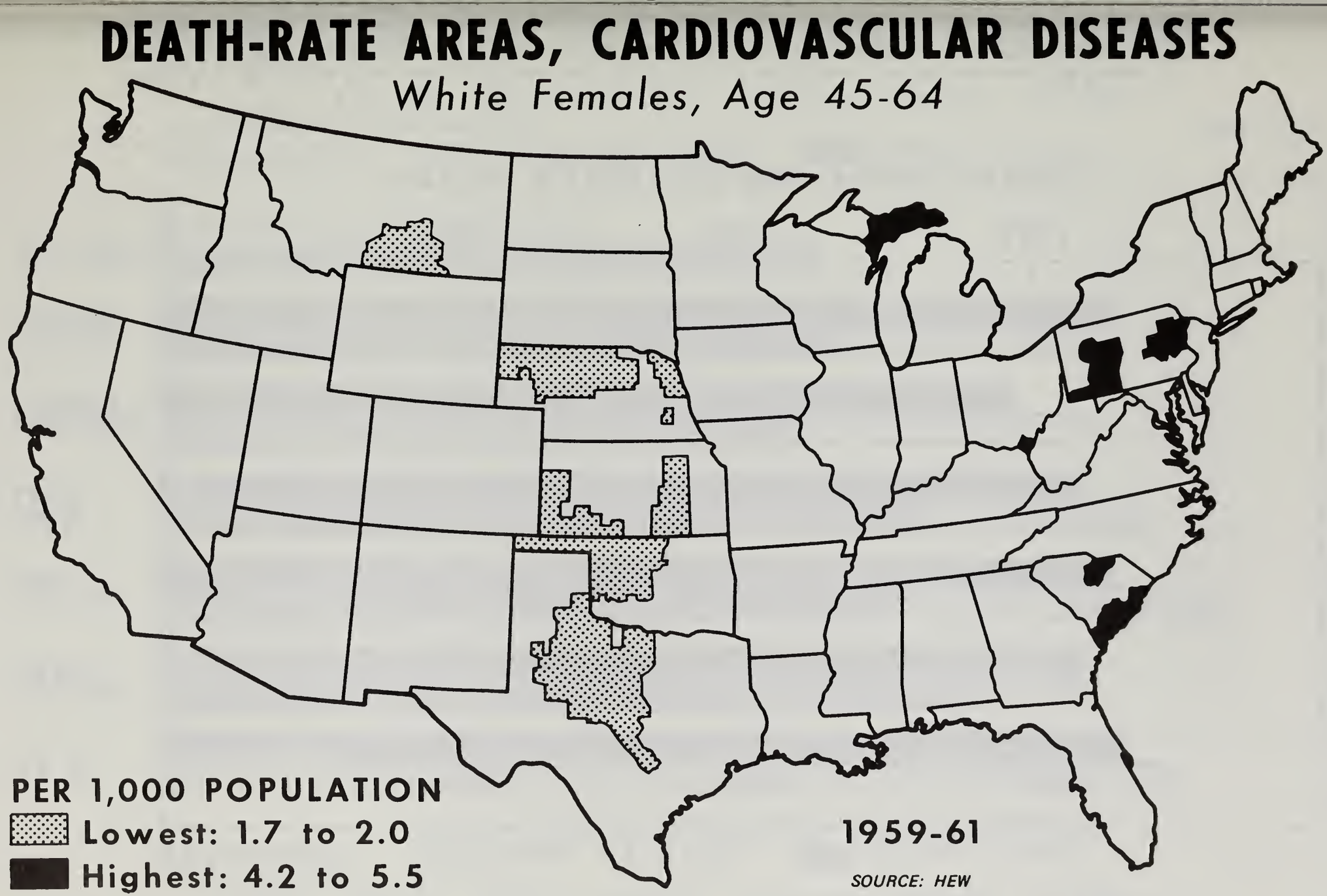
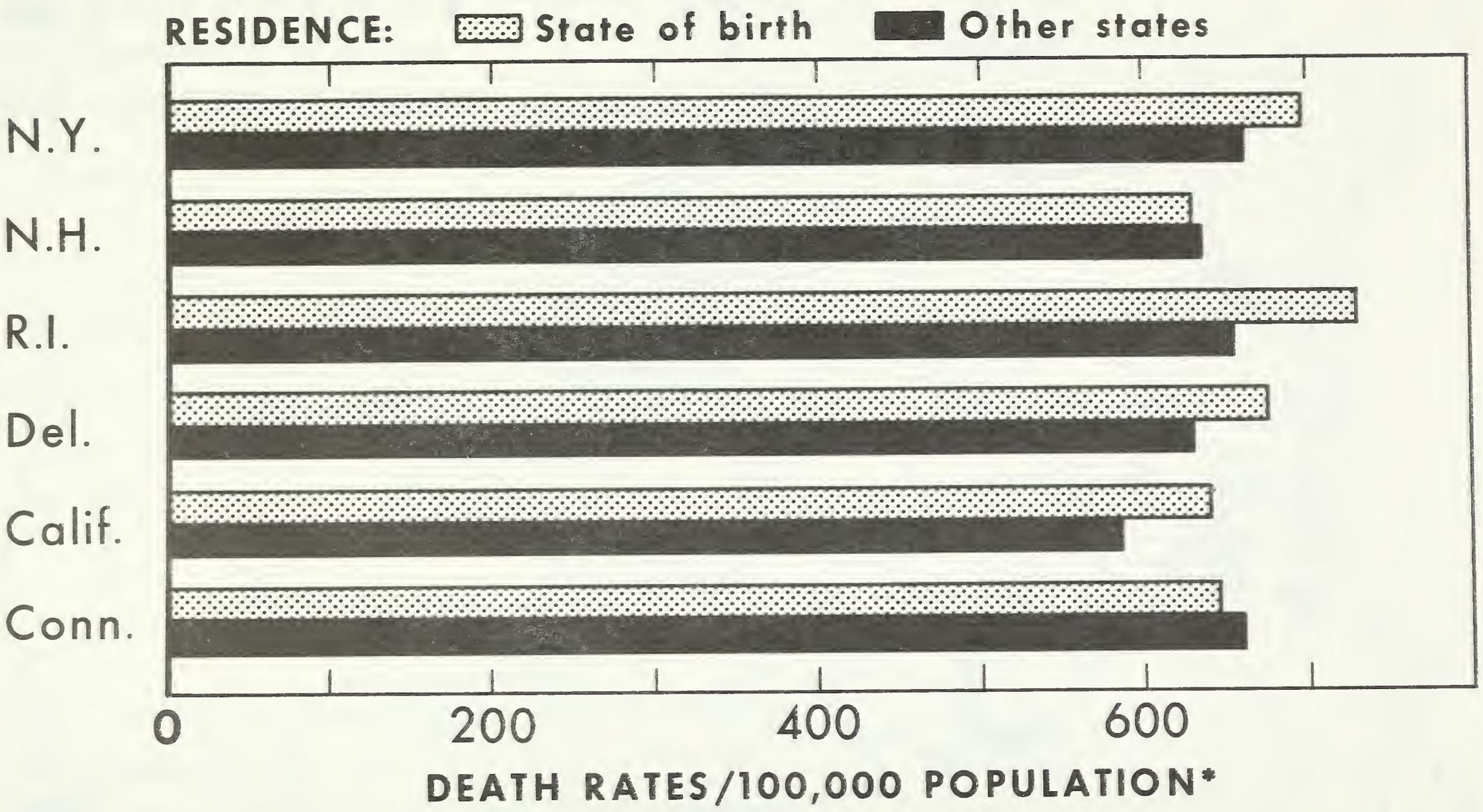

DEATH-RATE AREAS, CARDIOVASCULAR DISEASES
White Females, Age 45-64
PER 1,000 POPULATION
Lowest: 1.7 to 2.0
Highest: 4.2 to 5.5
1959-61
SOURCE: HEW

Figure 8

MIGRATION AND CARDIOVASCULAR DISEASES

High Death Rate States, White Males, 1950



*AGE ADJUSTED TO U.S. TOTAL POPULATION

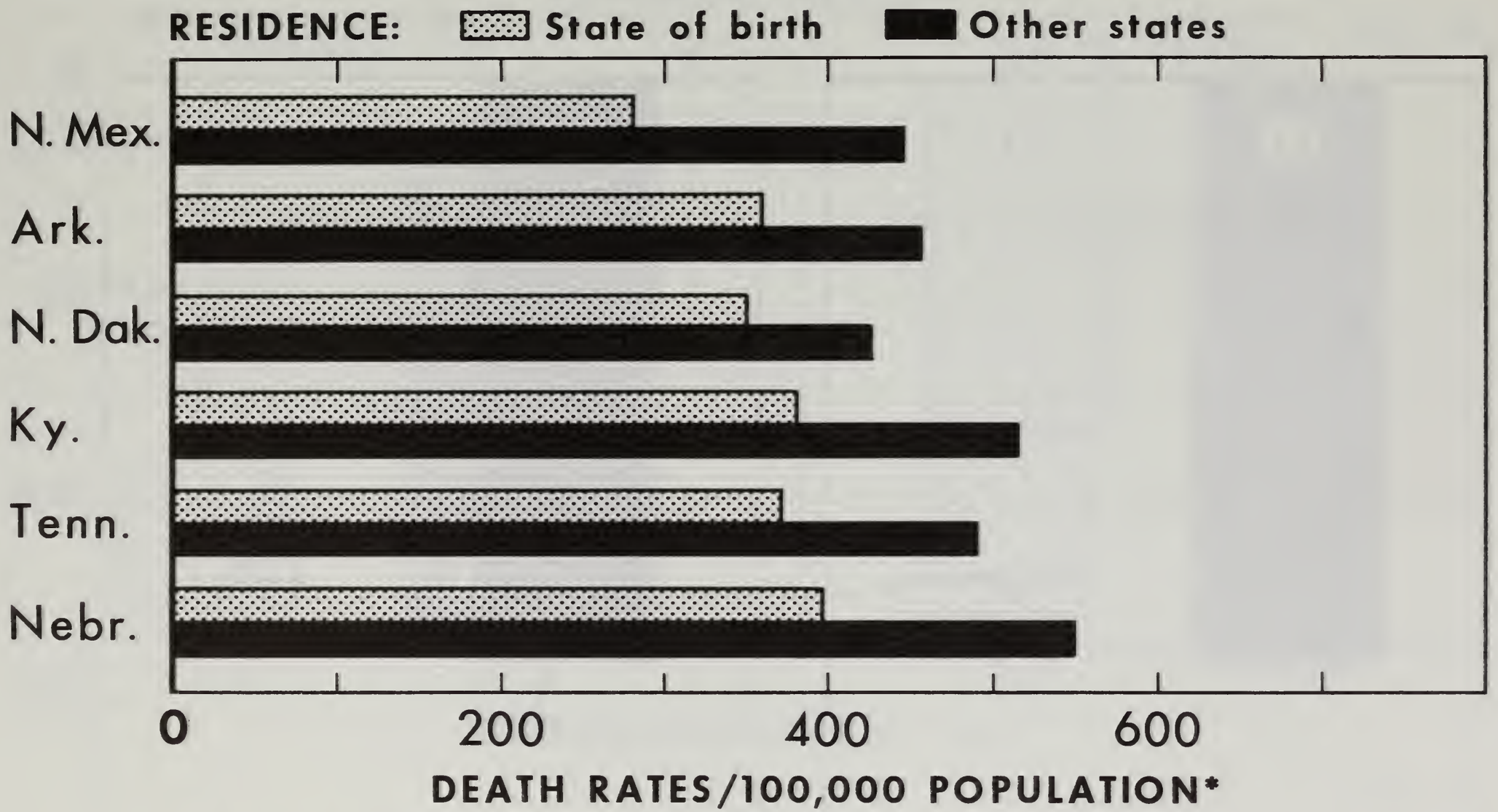
SOURCE: HEW

Figure 9. — Migration from high death rate areas for heart and vasculatory diseases decreases likelihood of death from that condition. Heredity, prenatal, infant and childhood environment, including diets also are factors. Coronary heart disease death rates are for white males ages 40-69, 1950 (age-adjusted to U.S. total population age 40-69 in 1950, by 10-year age groups).

MIGRATION AND CARDIOVASCULAR DISEASES

MIGRATION AND CARDIOVASCULAR DISEASES

Low Death Rate States, White Males, 1950



*AGE ADJUSTED TO U.S. TOTAL POPULATION

SOURCE: HEW

Figure 10. — Migration from low death rate areas for heart and vasculatory diseases increases likehood of death from that condition. Heredity, prenatal, infant and childhood environment, including diets also are factors. Coronary heart disease death rates are for white males ages 40-69, 1950 (age-adjusted to U.S. total population age 40-69 in 1950, by 10-year age groups).

OBESITY MAY INCREASE RISK OF STROKE

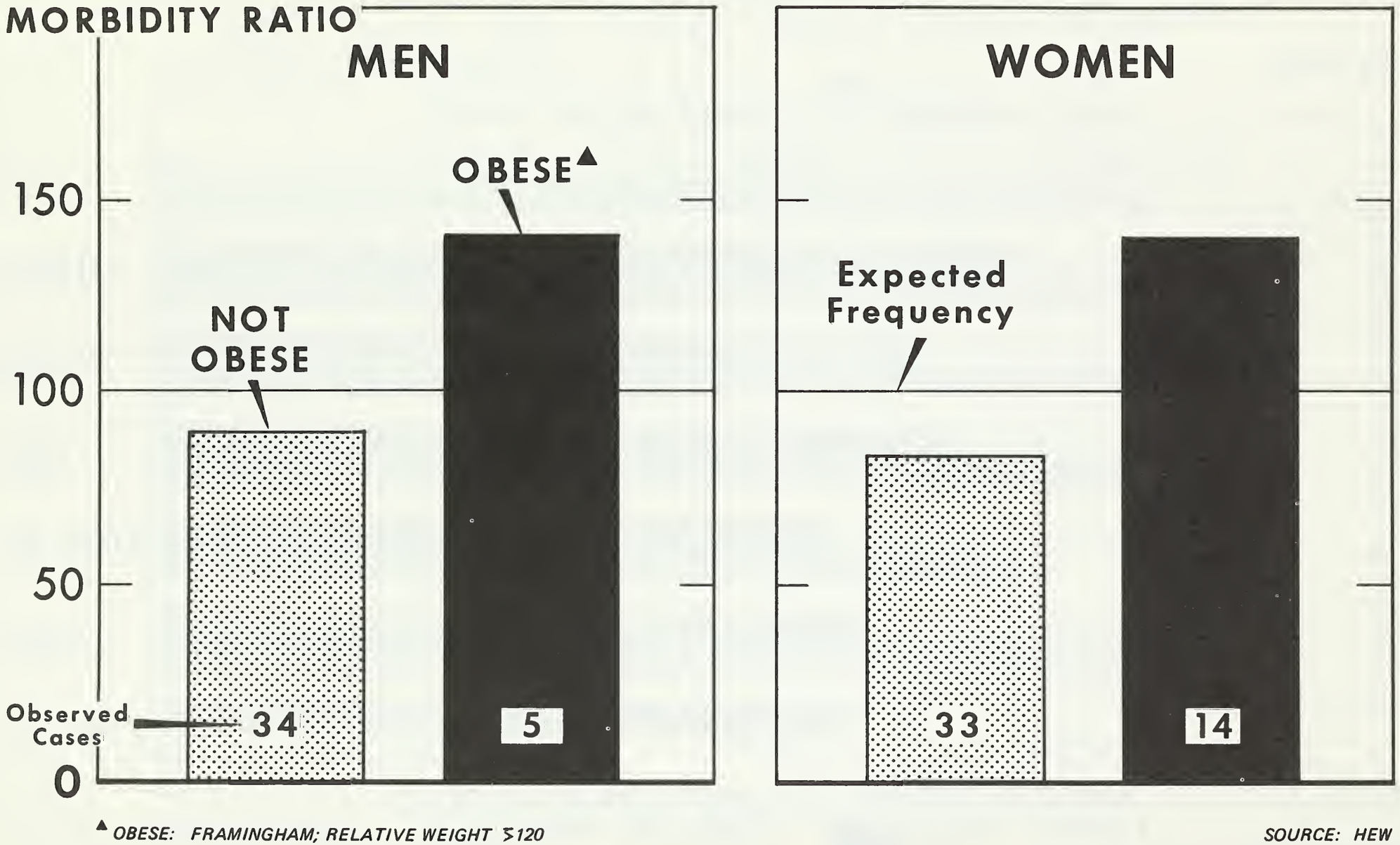
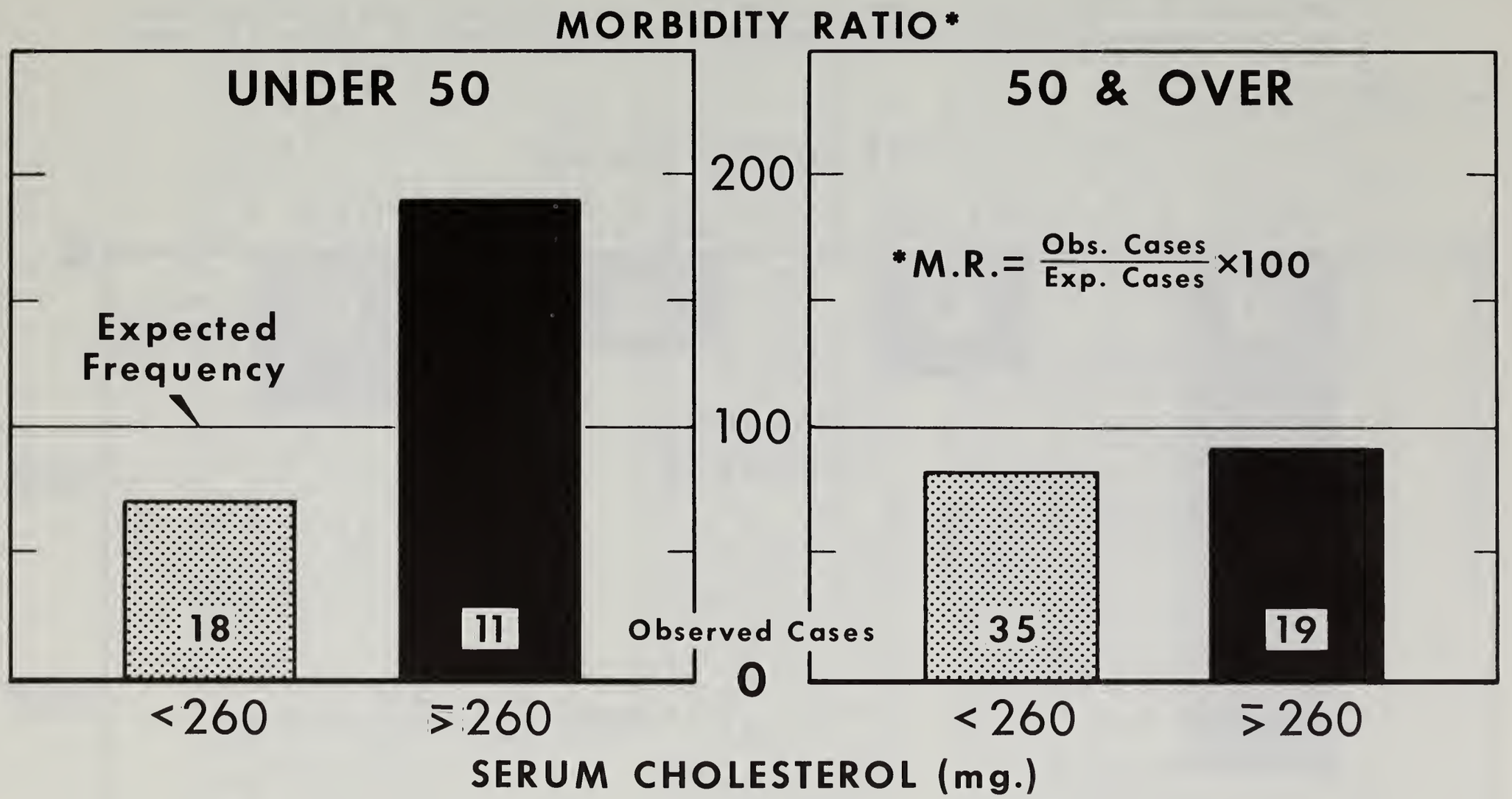


Figure 11. — The risk of stroke may be increased by obesity, but the increase in risk is relatively modest. The major threat inherent in obesity may be that it is often accompanied by an increase in blood pressure. Obesity also increases the work load of the heart and appreciably increases the individual's risk of angina and sudden death. Surprisingly, it does not appear to influence risk of a myocardial infarction.

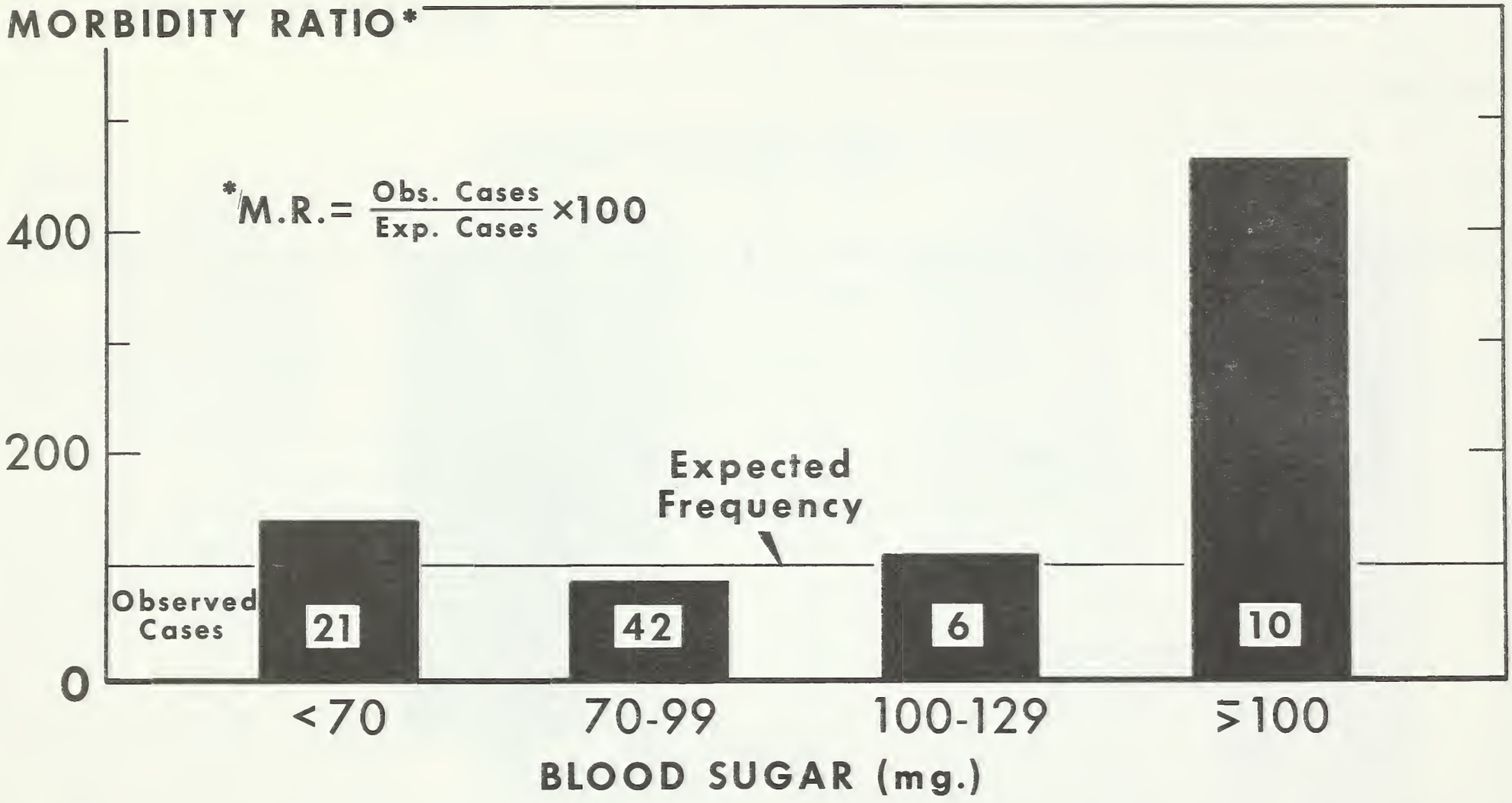
CHOLESTEROL AND RISK OF STROKE



SOURCE: HEW

Figure 12. — Elevated blood cholesterol levels obtained in subjects under 50 were strongly associated with an increased risk of stroke. Elevated blood lipid levels have been a factor consistently associated with increased susceptibility to atheroselerosis. After age 50, blood lipid levels are not reliable as indicators of susceptibility to either stroke, coronary heart disease or occlusive peripheral vascular disease.

BLOOD SUGAR LEVEL AND RISK OF STROKE



SOURCE: HEW

Figure 13. — Evidence of impaired carbohydrate metabolism is associated with increased stroke risk. The relationship between diabetes and disease of the heart and blood vessels is well documented. An increased risk of stroke was observed even among those with moderately elevated blood sugar and possibly also among those with an abnormally low blood sugar. The reason for the apparently increased risk associated with a low blood sugar may also reflect an early phase of impaired carbohydrate metabolism.

Despite great advances in the control of infectious diseases in the past decades, acute respiratory infections remain the most frequent cause of illness and the most important cause of loss of time from work and school in the U. S. (Tables 6,7). Pneumonia and influenza ranked fifth and other bronchopulmonic diseases tenth as causes of death in the U. S. in 1967; together they accounted for over 85,000 deaths. Acute respiratory infections are the most important single cause of illness. One-third to one-half of industrial absenteeism from sickness is caused by acute respiratory infections. In addition, mild infections may reduce efficiency without occasioning absenteeism. Young adults and children suffer the highest incidence of these infections, while the long lasting morbidity associated with chronic diseases is more frequent in older adults. The economic importance of morbidity from acute respiratory infections is impossible to determine precisely, but it has been estimated to be well over five million dollars per year. In addition, one billion dollars alone are spent for cold remedies and facial tissues.

Diet and the nutritional state of the individual involved are clearly associated with the incidence, duration, and severity of respiratory and infectious diseases. Nutrition is most likely to be a factor when the lower respiratory tract is involved, when bacteria are involved, or a chronic condition exists. Individuals in good nutritional state are less likely to succumb to the disease and those with high levels of nutrient reserves are more likely to recover quickly. These reserves are of special importance when the disease state results in loss of appetite due to coughing and vomiting, and increased caloric expenditure due to added difficulty in breathing.

There are many reports that malnutrition lowers resistance to infection and that nutritional deficiencies may be precipitated by an acute infection in subjects with borderline nutrient inadequacies. Few statistics are available to show a direct relationship between nutrition and infection. One of the best studies was carried out in Guatemala at INCAP. Three matched villages were studied. In two, health measures were introduced, the third remaining as a control. The health measures in one village involved adding supplementary food to the diet of children during and after weaning; in the other village, preventive and curative medical care was offered. Overall death rates declined in all three villages beyond what was expected from trends prior to the study. Reductions in mortality were as follows: in the medical care village 31 percent (50 percent beyond that expected), in the feeding village 56 percent, and in the control village 38 percent. Fully half of the deaths occurred during the second year of life.

Further evidence of the relationship between nutrition and infection rate has been observed. Virus infections hit harder among the undernourished, and the severity of the infection is directly proportional to the degree of malnutrition--these data are from studies with mice. Acute diarrhea in young infants results from a synergism between poor nutritional state and infection.

In children, acute infections such as pneumonia, rheumatoid arthritis, acute tonsillitis, and rheumatic fever reduce the levels of vitamin A in the blood as does vaccination against small pox and measles. Xerophthalmia, night blindness, frequently follows these infections indicating the depletion of body reserves of vitamin A. Vitamins B_1, B_6, and C, and protein also are implicated. Unfortunately, there are no satisfactory ways to determine the extent of body stores for most nutrients or to identify the level of nutrient intake needed to maintain adequate stores for resistance to infection.

Despite major advances in drug treatment prior to 1950, the incidence of respiratory and infectious disease remains high for the very young, 1 to 4 years, whose body reserves are low. The incidence increases with age where the cumulative effects of a lifetime of chronic marginal nutrient intake and reserves show up (Fig. 14).

The manner by which good nutrition and diet combat infectious diseases is not well understood. Healthy cells and membranes may be more resistant to the entry of microorganisms. Protein, several vitamins, and minerals are needed to produce the antibodies to resist and recover from infectious diseases, although their role in the production of antibodies is not clear.

Recent studies with animals have shown a direct relation between specific nutrients and production of antibodies to specific stimuli such as disease organisms or organ transplants. The relationship exists when a specific nutrient, usually a vitamin, is lacking in the diet. Increased resistance to disease has not been demonstrated when individual vitamins are added to marginal or normal diets.

Lung irritants present in the atmosphere, such as ozone and nitrogen dioxide, are an increasingly important contributor to respiratory problems. Vitamins A and E may help protect the lungs from the adverse effects. Vitamin A is essential for production of healthy mucus-secreting tissue in the lung while vitamin E may protect the vitamin A from destruction by air pollutants.

Diet is additionally involved in the transmission of several infectious diseases including salmonellosis, typhoid fever, dysentery, hepatitis, and gastroenteritis. Most of these diseases are transmitted through contamination of food and water supplies. Statistics on the incidence of illness from food poisoning are inadequate. Only those cases are recorded where the causative organism is isolated from both the food and the stricken individuals. Probably not more than one percent of all cases of food poisoning are reported. The causative organisms, primarily salmonella, clostridium perfringens, and staphylococci, are widely distributed in food. They become a health problem when the food is improperly handled and the microorganisms have the opportunity to grow, reproduce, and in some instances produce toxins. About 99 out of 100 cases of food poisoning are due to improper handling of food during preparation and storage by the consumer.

In 1966, it was estimated that two million Americans or one percent of the population suffered from attacks of salmonellosis often self-diagnosed as "24-hour flu" or stomach upset. If the average duration of each incidence is two days then a total of 1.5 million work days were lost. The estimate of two days per incident is considered conservative.

Chronic and respiratory diseases other than tuberculosis are at the present time rapidly increasing in the U. S. For example, since 1949 the death rate for pulmonary emphysema with or without chronic bronchitis, has increased faster than that for any other leading cause of death. The rate of increase in death and incidence is of epidemic proportions. About one percent of deaths of males and 0.5 percent of deaths of females are caused by chronic nontuberculous respiratory diseases. Atmospheric pollution, cigarette smoking, and constitutional factors are implicated as important causes of the chronic respiratory diseases. Some of them such as bronchial asthma may be allergic disorders (ALLERGIES).

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TABLE 6

Incidence of respiratory and infectious conditions by age group in 1967

Age group (in years)	Number of conditions[1]		Rate per 100 population	
	Infective and parasitic	Respiratory	Infective and parasitic	Respiratory
Total	45,526	201,016	23.7	104.5
Under 5 years	10,063	39,708	51.4	202.7
5-14 years	17,336	54,907	43.0	136.2
15-24 years	5,643	31,168	18.7	103.3
25-44 years	7,244	39,311	16.0	87.1
45-64 years	4,108	26,602	10.5	67.8
65 and over	1,133	9,321	6.3	52.1

[1]In thousands for year ending June 30. Data refer to civilian noninstitutional population. Estimates include only acute conditions which were medically attended or caused at least one day of restricted activity.

Source: National Center for Health Statistics 1968 PHS publ. 1000, series 10, no. 44, U. S. Dept. of Health, Education, and Welfare; and U. S. Bureau of the Census, Statistical Abstract of the United States: 1969, 90th ed., p. 77, table 104.

TABLE 7

Incidence of acute conditions and days lost from work and school: United States, July 1965-June 1966[1]

	Incidence in thousands	Days lost in thousands		Days lost per 100 persons per year	
		School	Work	School	Work
Respiratory conditions	240,069	122,422	119,980	288.3	164.1
Infectious and parasitic diseases	47,909	43,375	20,966	102.1	28.7
Total	287,978	165,797	140,946	390.4	192.8

[1]Data are based on household interviews of the civilian, noninstitutional population.

Source: National Center for Health Statistics 1967 PHS publ. 1000, series 10, no. 37, tables, 4, 7, and 8. U. S. Dept. of Health, Education, and Welfare.

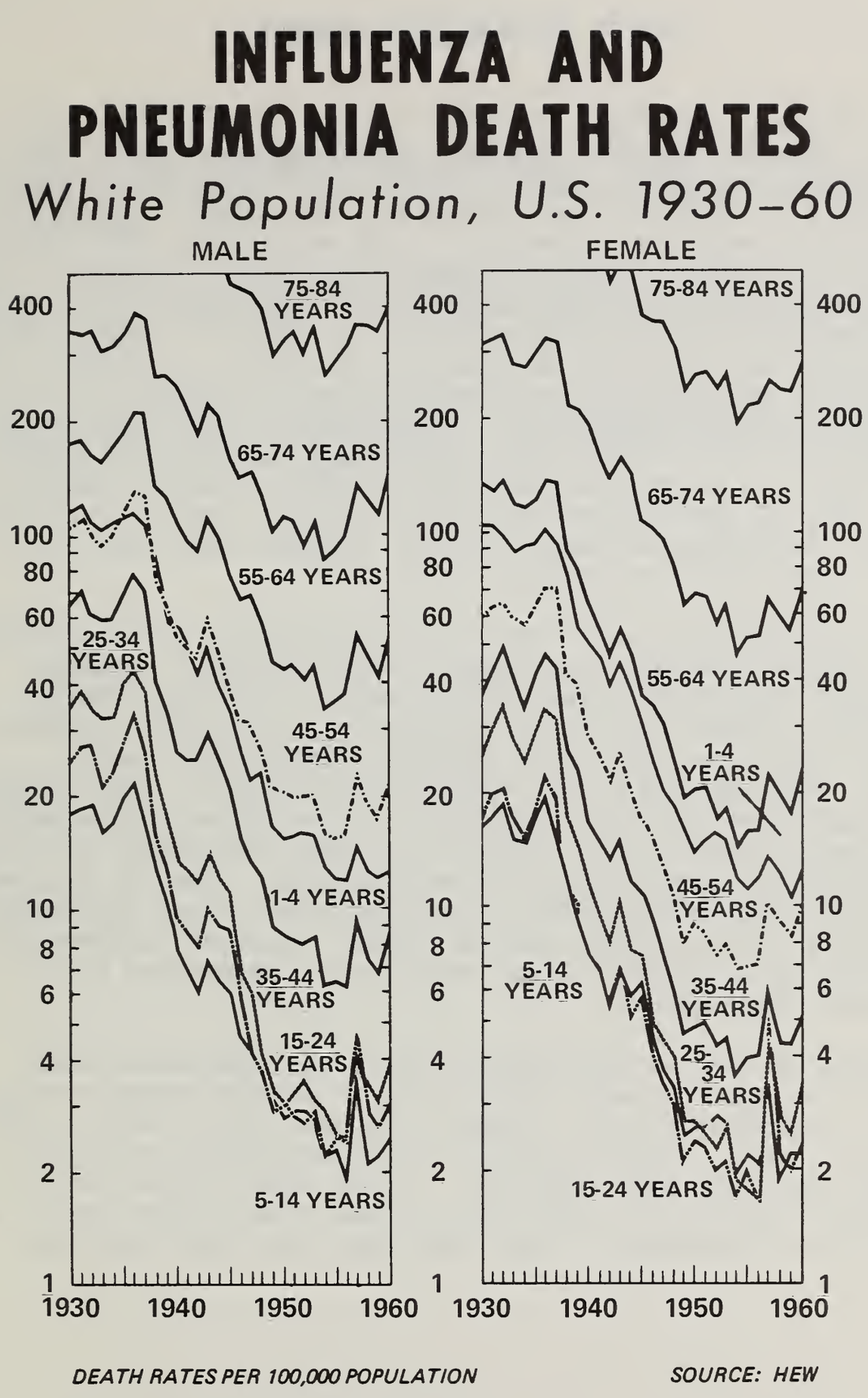

Figure 14. — Death rates per 100,000. Death rates are high for the very young whose nutrient reserves are less. The rates increase with age where the accumulative effects of chronic marginal nutrient intake and reserves are likely to show up. Rates are higher for nonwhites who also are more likely to have had poor diets.

Mental illness is difficult to define and even specialists in the field are dissatisfied with present classifications. Thus, data on its incidence vary widely. Estimates of impaired disability due to disturbances of thought, mood, perception, and behavior, vary from one percent to more than 20 percent of the population. The National Association for Mental Health estimates that 19 million people in the United States (about 1 in 10) are afflicted with some form of mental or emotional illness requiring mental care. Moreover, mental disorders are a significant factor in many physical illnesses. Estimates, based on a study by the Commission of Chronic Illness in Baltimore in 1952-55, and other data indicate that at any point in time 12 percent of the population are suffering from psychiatric disorder and that 2.5 percent (over 52 million persons) are severely or totally disabled by it. Only 19 percent were considered entirely free of psychiatric symptoms. Prevalence of mental illness increases with age and is higher in the lowest socioeconomic groups.

A direct relationship can be drawn between nutrition and much of the mental illness resulting from organic brain disorders. Dietary improvement results in increased resistance to infection, better management of alcoholics, fewer circulatory disturbances and cardiovascular conditions, control of metabolic disturbances due to diabetes, hyperthyroidism, and nutrient deficiencies. The relationship of nutrition and mental disorders not associated with organic brain damage is less clear. There is no doubt that mental disorders can lead to poor eating habits and malnutrition. Also, it is clearly established that good nutrition is necessary for proper development and function of the central nervous system. Recovery from mental disability can be delayed if the condition is complicated by nutritional inadequacy.

Conceivably as much as 80 percent of the U. S. population could benefit from improved mental health with 12 percent having a major benefit. Benefits would be economic, through reduced hospital and psychiatric costs, improved ability and opportunities on the job, and fewer work days lost (Table 8). Social benefits would be of even greater importance; less family stress, fewer broken homes, and greater social acceptance of the individuals and their families.

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TABLE 8

Disability from psychoneuroses and psychoses

Ages	Annual incidence per 1,000 personnel	Annual days per 1,000 personnel	Average days per claim
Males			
Ages 17-64	4.4	549.2	123.7
17-24	2.7	282.3	102.7
25-44	3.3	300.0	91.4
45-64	6.6	990.5	150.5
Females			
Ages 17-59	7.3	870.1	119.2
17-24	4.3	517.8	121.0
25-44	9.3	1113.3	120.3
45-59	10.5	1232.9	116.9

Metropolitan Life Insurance Company personnel claims incurred in 1963-64 traced to end of 1965.

The figures are based on temporary disability under the Company's Insurance and Retirement program. The first seven days of illness and disability days beyond a year are not included in the above figures.

Personnel in the Pacific Coast states and in Canada are not included.

Source: Mental Illness at the Working Ages 1967 Statistical Bull. 48: 6, Metropolitan Life Insurance Company.

INFANT MORTALITY AND REPRODUCTION

In 1968 there were approximately 3.5 million children born in the U. S. Of these live births, 75,000 infants died within the first year of life. The infant mortality rate in the U. S. has shown a constant decline during this century, but it has not declined as rapidly, or to as low a level, as in several other countries (Table 9, Figs. 15,16). In 1950, the U. S. ranked sixth among a group of countries with characteristics which make comparison possible. In 1961-63, the U. S. had moved to tenth place and to thirteenth in 1968. Sweden had the lowest average annual infant mortality rate, about 13 per thousand in 1968. In 1968, the infant mortality rate in the U. S. was 21.7, a slight decrease from 22.4 in 1967. The mortality rate for white infants in 1967 was 19.7 per thousand as compared with 35.5 for nonwhite infants (Table 10). A large part of these infant deaths were neonatal or occurred during the first month of life. Neonatal death rate was 16.5; with the rate for white infants being 15.0 as compared with 23.8 for nonwhite infants. The large proportion of the neonatal deaths occurred in infants who were small at birth, either because they were "prematurely" born, or because they were "small-for-date" infants. Since 1960, about 325,000 "premature" babies, "babies with birth weight of 5.5 pounds or less", have been born in the U. S. each year.

The infant mortality rate for nonwhites was 40.3 in 1965, nearly double the rate in the nonwhite population. The same causative factors apply that make for high rates among the poor: premature termination of pregnancy, lack of health and medical care services, inadequate diet and health practices, and inadequate living conditions. The impact of the level of living on infant survival is illustrated by the fact that the post-neonatal (age 1-11 months) death rate in the 17 states with the lowest per capita income was over a third above the national average in 1965.

The incidence of low birth weight in the U. S. is increasing. In 1950, 7.6 percent of live-born infants were "premature"; in 1960, 7.7 percent; and in 1964, 8.2 percent. Among the white infants, the incidence has hovered about 7.0 percent. The incidence among nonwhite infants increased from 10.4 percent in 1950 to 13.8 percent in 1964. To a large extent, these small babies are the result of poor fetal nutrition. Recently developed techniques for taking intra-uterine fluid samples will make it possible to identify and study nutritional problems during the fetal period. Until the development of this technique, very little was known about the direct interrelationship of nutrition and fetal development in humans.

A number of studies have been done with animals showing the severe effects upon the full-term animal fetus of nutritional deficiencies during pregnancy. Zinc deficiency will cause such skeletal malformations as cleft palate, cleft lip, club feet, missing eyes, missing vertebra, and abnormalities of other body systems. A manganese deficiency during pregnancy produces abnormal body righting reflexes in the young.

The first evidence that a change in maternal nutrition could disrupt the normal development of mammals appeared in 1935. The relationship was established between diets deficient in vitamin A and a variety of birth defects including missing eyes in pigs. Since that time, a number of abnormalities have been deliberately induced by nutritional deficiencies. Among the nutrients studied were riboflavin and folic acid. Significantly, folic acid and vitamin A are two of the vitamins most likely to be deficient in the U. S. diet.

One of the earliest deficiencies to be recognized for its effect on prenatal development was a deficiency of iodine. This results in the birth of a somewhat overweight, but seemingly normal, infant. However, by the sixth month, the clinical picture of cretinism is clearly defined. This is of particular economic significance in the U. S. at the present time because of the increasing prevalence of goiter in several parts of the U. S. among girls of childbearing age. This increased incidence may be due to the increasing consumption of prepared foods made with salt which has no iodine added.

Since 1910 the percentage of infant deaths due to birth defects has steadily increased. Many millions of children have handicaps (Fig. 17). In fact, the 1964 Vital Statistics Survey in the U. S. showed that congenital defects, including genetic metabolic disorders, was the leading cause of death in the first year. At least 62,000 deaths each year in all age groups in this country may be attributed to birth defects. Actually, as a cause of death, birth defects are outranked only by heart disease. The National Foundation has estimated that today in the U. S. there are 15 million persons with one or more congenital defects that affect their daily lives. There is considerable evidence relating to the relevance of birth defects to poor nutrition. The Health Insurance Program of New York and others have found that babies who weighed less than 5.5 pounds at birth are twice as likely to have birth defects. Some of these relationships have been discussed elsewhere (EYESIGHT). The incidence of blindness is two to three times as high in infants of low birth weight. The long-range effects of malnutrition on brain development are discussed in IMPROVED LEARNING ABILITY.

Malnourishment in the mother usually results in the birth of a baby who is underweight. These babies are more likely to have birth defects. This has particular significance in the U. S. where there are probably more child pregnancies than in any other nation in the world (Table 11). In 1965 in the U. S., there were more than 196,000 live births to girls 17 years of age or younger. Statistics are not available to show the relation of the age of the mother to the incidence of birth defects. However, young mothers are in the sex-age group most likely to have nutritional deficiencies as indicated by the National Nutrition Survey and the data for individuals obtained during the Nationwide Food Consumption Survey of 1965. In the Nationwide Nutrition Survey of 1968 in Louisiana, 40 percent of 7- to 17-year-olds had unacceptable plasma vitamin A values. This vitamin has been implicated in birth defects.

Complications during pregnancy resulting in maternal death may also be related to the nutritional state of the mother. In 1967, the maternal death rate was 28.0 per 100,000 live births. The rate for white mothers was 19.5 and for nonwhite mothers 69.5 (Table 10). While hygiene and other factors are also causative agents, the role of nutrition may be very important particularly with the nonwhite mothers, many of whom are from low economic groups. There are a number of ways in which nutrition influences maternal death. The frequency of misshapen pelvic bones, a cause of difficult labor and frequently of adverse effects on the infant, has been much reduced by the prevention of childhood rickets. Because the principal cause of rickets is an inadequate intake of vitamins A and D and is more often present among economically deprived populations, we have an example of the influence of economic status and malnutrition in early life on the outcome of pregnancies many years later.

Nutrition has been recognized as a possible major cause of the toxemias of pregnancy for several years. The specific nutrient involvement is not well understood. The relative importance of nutrition in the cause and course of toxemia in pregnancy has been the subject of controversy for many years. Greatest interest has centered on the intake of calories, protein, and salt. It appears likely that the problem is the result of a very complex metabolic disturbance involving abnormal hormone activity and an unbalanced dietary intake, particularly an abnormal intake of salt. Vitamin B_6 also has been implicated. The clinical pattern and geographic distribution of pre-eclampsia is reminiscent of primarily nutritional disorders, particularly pellagra.

The increased nutritional needs of women during pregnancy has been recognized for many years. Yet information from human metabolic studies on the nutritional requirements of this important group is only fragmentary, and few new studies have been made in the past 15 years.

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TABLE 9

Live births and infant deaths

(Prior to 1960, excludes Alaska and Hawaii.
See also Historical Statistics, Colonial Times to 1957)

Year	Number (thousands)		Rate per 1,000 population	
	Births[1]	Infant deaths[2]	Births[1]	Infant deaths[2]
1910	2,777	NA	30.1	NA
1915	2,965	78[3]	29.5	99.9[3]
1920	2,950	130[3]	27.7	85.8[3]
1925	2,909	135[3]	25.1	71.7[3]
1930	2,618	142[3]	21.3	64.6[3]
1935	2,377	120	18.7	55.7
1940	2,559	111	19.4	47.0
1945	2,858	105	20.4	38.3
1950	3,632	104	24.1	29.2
1955	4,104	107	25.0	26.4
1960	4,258	111	23.7	26.0
1962	4,167	105	22.4	25.3
1963	4,098	103	21.7	25.2
1964	4,027	100	21.0	24.8
1965	3,760	93	19.4	24.7
1966	3,606	86	18.4	23.7
1967	3,521	79	17.8	22.4
1968 (prel.)	3,467	75	17.4	21.7

NA - not available.

[1]Through 1955 figures adjusted for underregistration.

[2]Represents deaths of infants under 1 year old, exclusive of fetal deaths; rates per 1,000 registered live births.

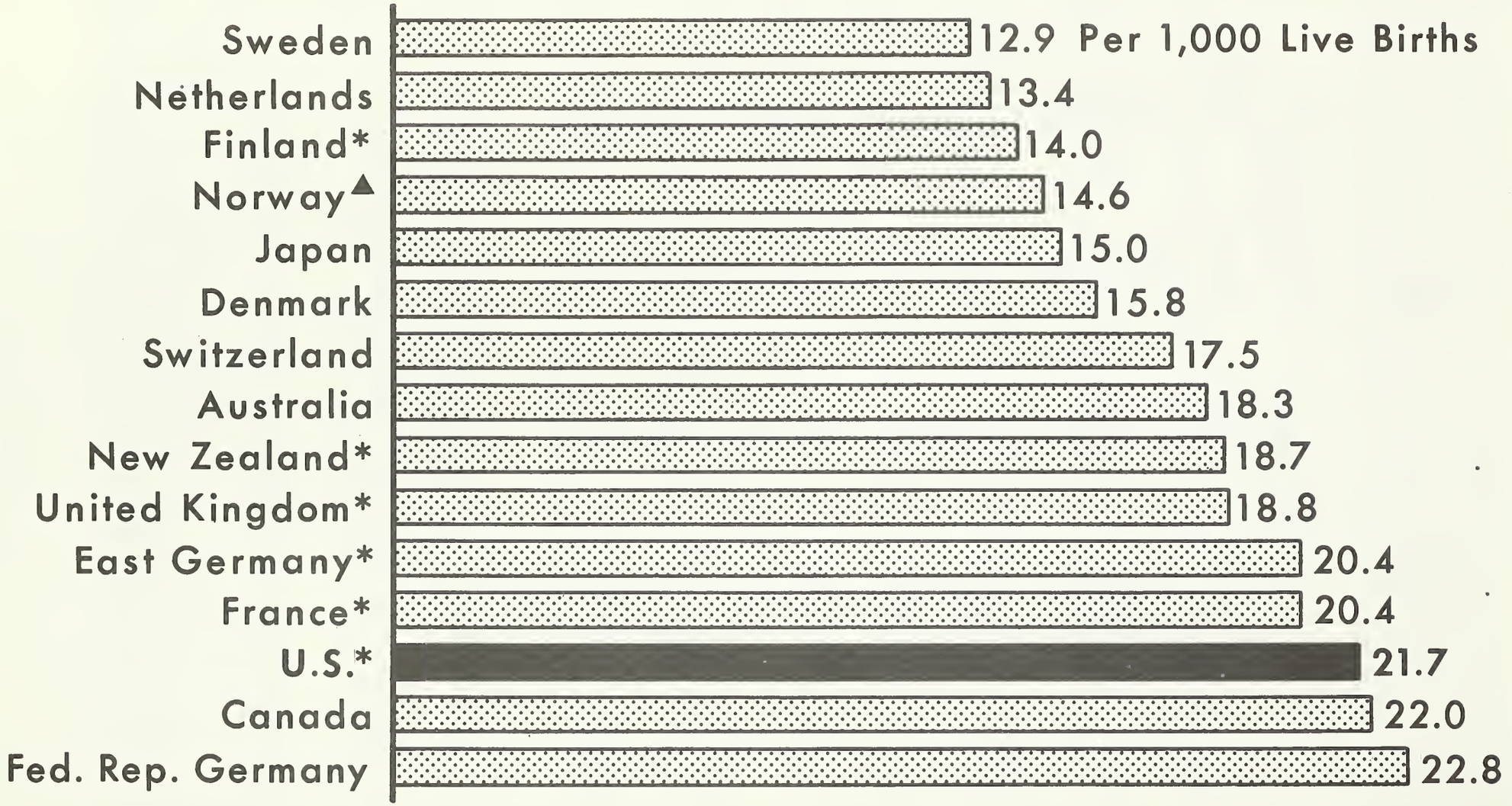
[3]Represents birth registration states only.

Source: U. S. Bureau of the Census. Statistical Abstract of the United States; 1969, 90th ed., p. 47, table 54.

COMMENT: INFANT MORTALITY HAS GRADUALLY DECLINED. THE U. S. FALLS FAR BEHIND MANY COMPARABLE COUNTRIES IN INFANT SURVIVAL. IN 1968, THE U. S. INFANT MORTALITY WAS STILL CONSIDERABLY HIGHER (21.7) THAN THE LEVEL REACHED BY SWEDEN (15.5) IN 1961-63.

INFANT MORTALITY RATE

Selected Countries

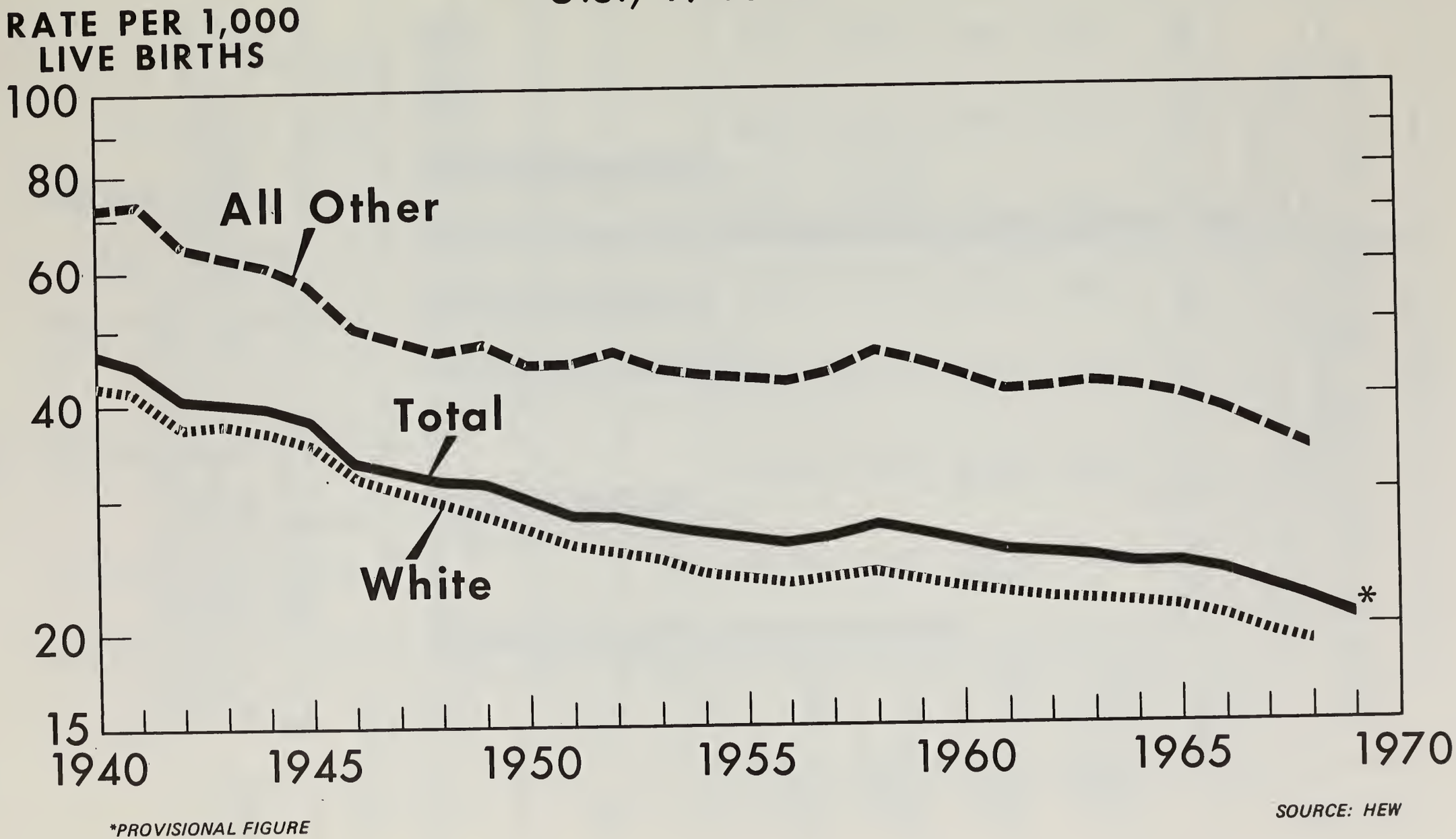


ALL DATA FOR 1967, UNLESS OTHERWISE INDICATED. ▲*1966* **1968* *SOURCE: HEW*

Figure 15

INFANT MORTALITY RATE

U.S., 1940-68



*PROVISIONAL FIGURE

SOURCE: HEW

Figure 16

TABLE 10

Infant, maternal, fetal, and neonatal death rates, by color: 1940 to 1967

(Deaths per 1,000 live births, except as noted, prior to 1960, excludes Alaska and Hawaii)

Item	1940	1945	1950	1955	1960	1965	1966	1967
Infant deaths[1]	47	38	29	26	26	25	24	22
White	43	36	27	24	23	21	21	20
Nonwhite	74	57	45	43	43	40	39	36
Maternal deaths[2]	376	207	83	47	37	32	29	28
White	320	172	61	33	26	21	20	19
Nonwhite	773	455	222	130	98	84	72	69
Fetal deaths[3]	NA	24	19	17	16	16	16	16
White	NA	21	17	15	14	14	14	13
Nonwhite	NA	42	33	28	27	27	26	26
Neonatal deaths[4]	29	24	21	19	19	18	17	17
White	27	23	19	18	17	16	16	15
Nonwhite	40	32	27	27	27	25	25	24

NA - not available.

[1]Represents deaths of infants under 1 year old, exclusive of fetal deaths.

[2]Per 100,000 live births from deliveries and complications of pregnancy, childbirth, and the puerperium.

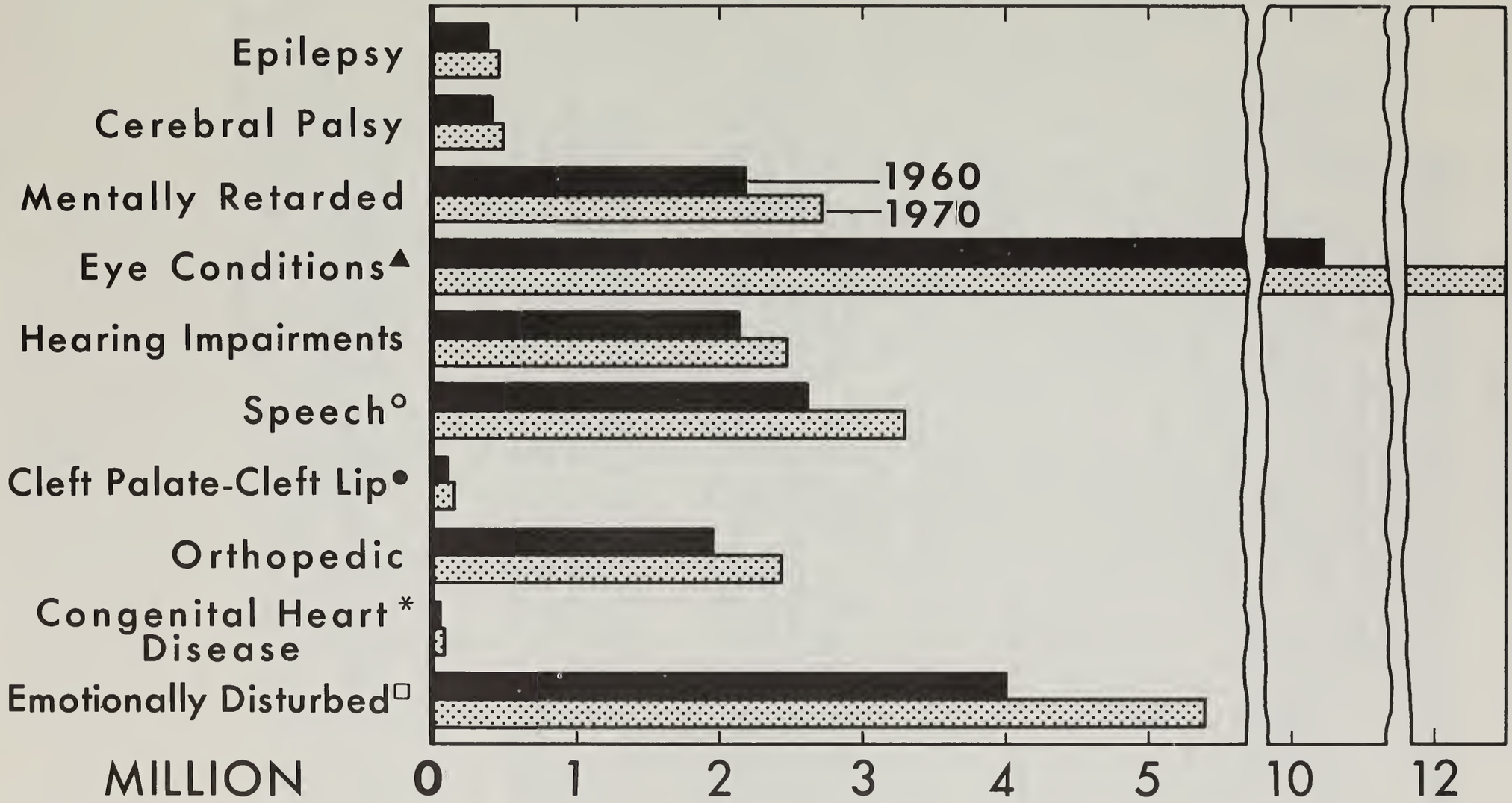
[3]Includes only fetal deaths (stillbirths) for which period of gestation was 20 weeks (or 5 months) or more, or was not stated.

[4]Represents deaths of infants under 28 days old, exclusive of fetal deaths.

Source: U. S. Bureau of the Census. Statistical Abstract of the United States; 1969, 90th ed., p. 55, table 70.

COMMENT: IN 1967, THERE WERE ABOUT 79,000 INFANT DEATHS. IF THE U. S. INFANT DEATH RATE WERE THE SAME AS IN SWEDEN IN 1961-1963, ONLY 54,576 INFANTS WOULD HAVE DIED. IN THIS ONE YEAR ALONE, OVER 25,000 LIVES WOULD HAVE BEEN SAVED.

MILLIONS OF CHILDREN HAVE HANDICAPS



UNDER 21 YRS.; UNLESS OTHERWISE INDICATED ▲*5–7 YRS.; EYE CONDITIONS NEEDING SPECIALIST CARE INCLUDING REFRACTIVE ERRORS*
°*5–20 YRS.* •*UNDER 18 YRS.* **BORN EACH YEAR* □*5–7 YRS.*

SOURCE: HEW

Figure 17

TABLE 11

Childbearing children in the United States, 1965

Number of babies born to mothers ten to fourteen years of age

Number of children born	White	Nonwhite	Total
One child	2,450	4,985	7,434
Two children	72	248	320
Three children	2	10	12
Four children	2	-	2
	2,526	5,242	7,768

Statistics are not available to show the relation of the age of the mother to the incidence of birth defects. However, a sample of the statistics provided by the National Center for Health Statistics showing the mother's age and the number of births is adequate to cause speculation. Note that two girls had had four children each by the time they were fourteen.

The United States probably has more child marriages and pregnancies than any other nation in the world. This creates the likelihood of a steadily increasing percentage of birth defects due to poor nutrition because, the younger the mother, the less likely she is to enjoy professional guidance during pregnancy and the more likely she is to commit all the nutrition sins common to teenagers.

Source: Hurley, L. S. 1968 The Consequences of Fetal Impoverishment. Nutrition Today 3(4):2.

Aging is an inevitable and irreversible process which begins no later than early adulthood. Improved diet has as a goal the deferment of the aging process so that people can benefit from better health, less pain, increased activity, and satisfaction during all of the lifespan. For maximum benefits, nutrition should be good from conception to death. The impact of fundamental aging changes become more obvious and important as man increases his ability to control infectious diseases, trauma, nutritional, and environmental stress. Death rates rapidly declined from 1938 to 1953 and then leveled (Fig. 18) largely as a result of improved control of infectious and parasitic diseases. Expectation of longer life improved as did the proportion of men and women surviving to adulthood and older ages (Fig. 19, Tables 12,13). Similar changes took place in most countries but some have plateaued at a lower rate than the U. S.; for instance, Denmark has a death rate of about 7.5 per 100,000 compared to 9.3 in the U. S. (Table 14). The mean lifespan in the United States has remained essentially constant since 1950 (Fig. 18). The rate of increase in mean lifespan in the future is likely to be slow unless new ways are found to inhibit biological degradation.

The nature of the aging process is not well defined. It is likely that changes in the concentration and structure of deoxyribonucleic acid (DNA) molecules are a major factor. DNA is formed only at the time of cell division and is of first importance in controlling the chemical activities of cells. Some cells do not divide after they reach maturity and in them the DNA is almost as old as the person of whom it is a part. The complex DNA molecules are exposed to attack by other cell constituents and by radiation-like effects. Eventually changes occur in the DNA molecule and the cell no longer functions efficiently setting in process a deteriorating sequence of events resulting in death. The best protection against the undesirable biochemical changes is for each cell to be optimally nourished throughout life.

The time between nutritional insult and measurable effect in terms of health may be quite long. A period of 40 or more years may elapse before a secondary manifestation occurs. Such is thought to be the case in Parkinson's syndrome characterized by neurological tremors and progressive rigidity of limbs, trunk, and face. Parkinson's disease is thought to be due to a deficiency of an enzyme essential in the metabolism of the amino acid phenylalanine which is critical to the formation of adrenalin.

The rate of aging varies widely among individuals as apparent from the number of persons over 65 years of age who continue to be both mentally and physically productive. During human evolution, men and women died young because of a hostile environment, and evolutionary pressures did not eliminate biologic processes which lead to deteriorative changes late in life or senescence. Gradually reduced are the functional performance of body systems and their ability to cope with stress, either external or internal. Early aging changes are seen in the incidence of chronic disease.

Neither all parts of the body nor all cell functions age at the same rate. As a result, there are changes in cellular metabolism and nutrient requirement profile. Many of the metabolic changes leave the individual susceptible to disease. The immune mechanisms of the body become weaker with age, increasing susceptibility to infections and possibly to cancer. Another example is found in the fact that most persons over 40 years of age metabolize glucose less efficiently than young persons. This impairment in carbohydrate metabolism may have an important bearing on the development of atherosclerosis; so also may the impairment of lipid metabolism indicated by the progressive rise in serum lipids that occurs with increasing age.

An estimated 93.7 million persons in the civilian, noninstitutional population, about 49.1 percent, reported one or more chronic impairments during the period from July 1965 to June 1966. The incidence of chronic conditions by age and sex is shown in (Table 15).

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U.S. DEATH RATES

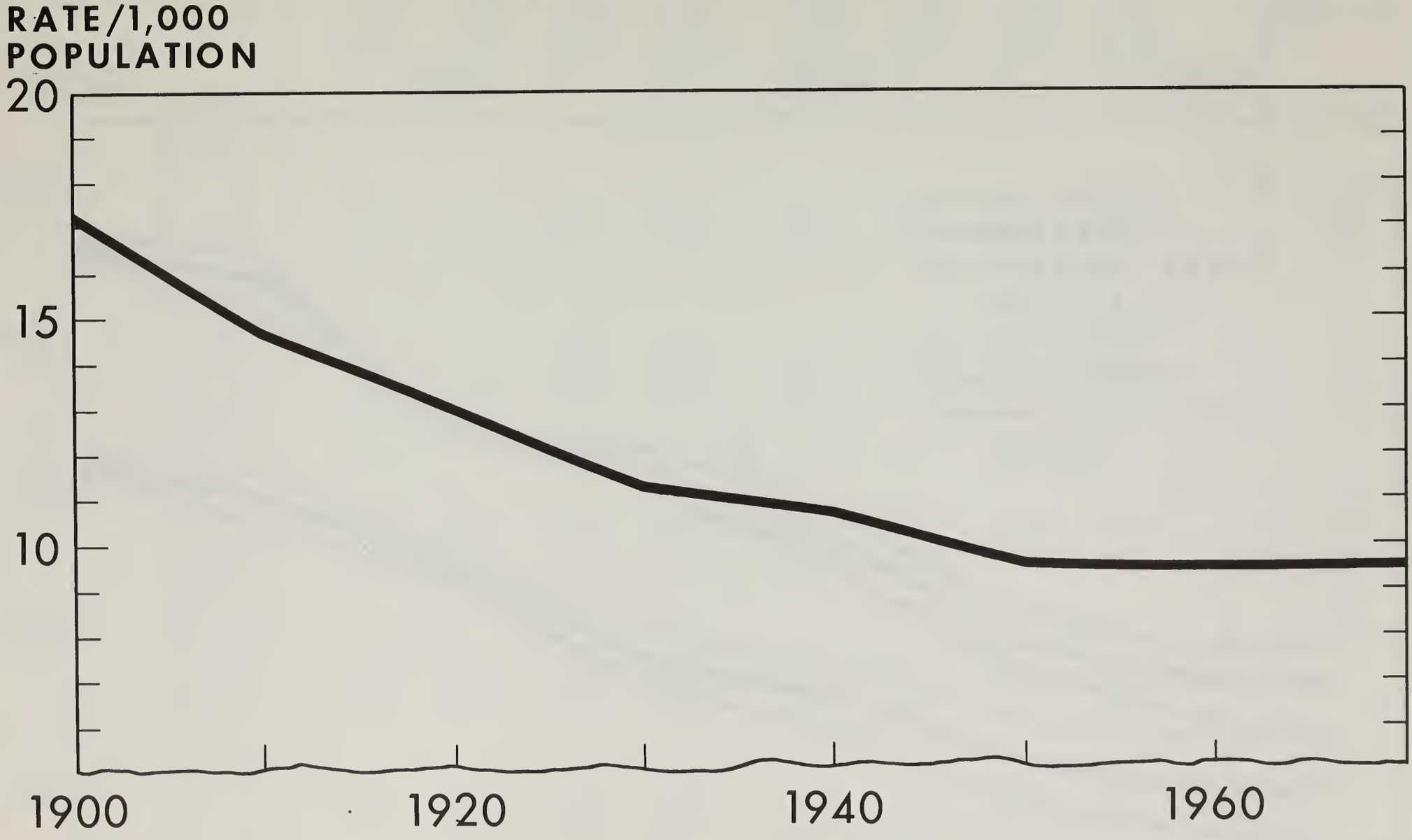

Figure 18

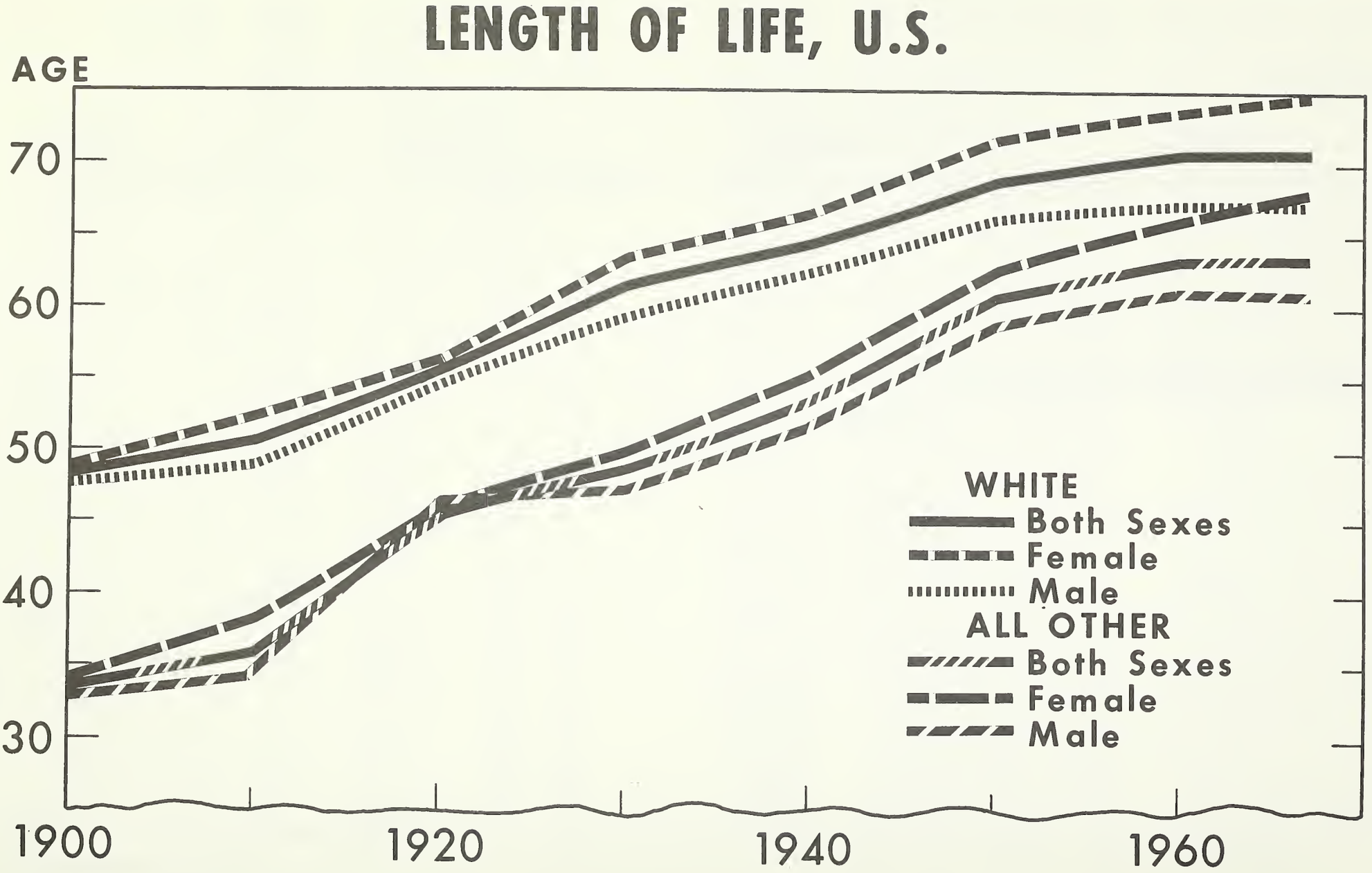

Figure 19. — Children born today have a greatly increased chance of reaching adulthood compared with those born at the beginning of the century.

TABLE 12

Average expectation of life in years

Age and sex	1900-1902	1919-1921	1939-1941	1959-1961	1967
			White		
At birth					
Male	48.2	56.3	62.8	67.5	67.8
Female	51.1	58.5	67.3	74.2	75.1
Age 20					
Male	42.2	45.6	47.8	50.3	50.2
Female	43.8	46.5	51.4	56.3	56.9
Age 40					
Male	27.7	29.7	30.0	31.7	31.8
Female	29.2	30.9	33.3	37.1	37.8
Age 65					
Male	11.5	12.2	12.1	13.0	13.0
Female	12.2	12.7	13.6	15.9	16.5
			Nonwhite		
At birth					
Male	32.5	47.1	52.3	61.5	61.1
Female	35.0	46.9	55.5	66.5	68.2
Age 20					
Male	35.1	38.4	39.7	45.8	44.8
Female	36.9	37.1	42.1	50.1	51.3
Age 40					
Male	23.1	26.5	25.2	28.7	28.3
Female	24.4	25.6	27.3	32.2	33.4
Age 65					
Male	10.4	12.1	12.2	12.8	12.7
Female	11.4	12.4	13.9	15.1	15.8

Source: U. S. Public Health Service, U. S. Life Tables and Actuarial Tables. 1939-41, Vital Statistics--Special Reports, vols. 41 and 52, U. S. Dept. of Health, Education, and Welfare; and Annual Report, Vital Statistics of the United States, 1968.

TABLE 13

Percent of population surviving to specified age

Age and sex	1900-1902	1919-1921	1939-1941	1959-1961	1967
			White		
Age 20					
Male	76.4	85.0	92.3	96.0	96.3
Female	79.0	87.3	94.0	97.1	97.5
Age 40					
Male	65.0	75.7	86.9	92.4	92.6
Female	68.0	77.6	89.8	95.3	95.7
Age 65					
Male	39.3	50.7	58.3	65.8	66.0
Female	43.8	54.3	68.7	80.7	81.5
			Nonwhite		
Age 20					
Male	56.7	79.1	86.8	93.1	94.0
Female	59.1	80.2	88.5	94.7	95.5
Age 40					
Male	43.0	61.4	72.8	85.8	85.0
Female	46.2	61.1	76.0	89.7	90.5
Age 65					
Male	19.0	34.1	35.9	51.4	50.2
Female	22.0	31.1	40.7	60.8	64.3

Source: U. S. Public Health Service, U. S. Life Tables and Actuarial Tables. 1939-41, Vital Statistics--Special Reports, vols. 41 and 52, U. S. Dept. of Health, Education, and Welfare; and Annual Report, Vital Statistics of the United States, 1968.

TABLE 14

Life expectancy at birth by sex for selected countries

Country	Expectation of life at birth				
	Year	Rank	Male	Rank	Female
Netherlands	1956-60	1	71.4	5	74.8
Norway	1956-60	2	71.3	1	75.6
Sweden	1962	2	71.3	2	75.4
Iceland	1951-60	4	70.7	4	75.0
Denmark	1962-63	5	70.3	7	74.4
Israel[1]	1964	6	70.2	14	72.9
Switzerland	1959-61	7	69.5	5	74.8
New Zealand	1960-62	8	68.4	9	73.8
Ireland	1960-62	9	68.1	20	71.9
France	1964	10	68.0	3	75.1
England & Wales	1961-63	11	67.9	8	73.9
Northern Ireland	1962-64	11	67.9	16	72.8
Japan	1964	13	67.7	14	72.9
Czechoslovakia	1963	14	67.5	11	73.4
West Germany[2]	1963-64	15	67.3	12	73.1
East Germany[3]	1960-61	15	67.3	19	72.2
Australia	1953-55	17	67.1	16	72.8
United States	1964	18	66.9	10	73.7
Scotland	1964	19	66.7	16	72.8
U.S.S.R.	1962-63	20	65.0	13	73.0

[1]Jewish population only.

[2]Including West Berlin.

[3]Including East Berlin.

Source: United Nations 1966 Demographic Yearbook 1965. United Nations, New York.

TABLE 15

Number and percent of persons with one or more chronic conditions, by sex and age: United States, July 1965-June 1966[1]

Sex and age	Total population in thousands	Persons with one or more chronic conditions	
		Number in thousands	Percent of population
Both sexes			
All ages	190,710	93,668	49.1
Under 17 years	66,840	14,950	22.4
17-24 years	22,393	9,671	43.2
25-44 years	45,185	26,756	59.2
45-64 years	38,713	27,316	70.5
65 & over	17,578	14,976	85.2

[1]Data are based on household interviews of the civilian, noninstitutional population.

Source: National Center for Health Statistics 1967 PHS publ. 1000, series 10, no. 37, table 9. U. S. Dept. of Health, Education, and Welfare.

ARTHRITIS AND RHEUMATISM

Arthritic and rheumatic diseases represent a number of musculo-skeletal conditions which cause a greater loss of time from work than any other set of health problems with the exception of nervous and mental disorders and respiratory diseases. This loss was recently estimated at 27 million days annually. About 16 million people in the U. S. are afflicted. About one of four victims of arthritis and rheumatism is restricted from carrying on any major activities and one of ten is confined to the home. Present estimates are conservative because there is little precise information regarding the true prevalence of the chronic rheumatic disorders in the general population. Recent estimates are that arthritic conditions cause unemployment each year to the equivalent of nearly one-half million people, cost the Government nearly 200 million dollars annually in lost income taxes, and account for about 12 percent of welfare expenditures. The total cost to the individuals involved and to the Government from arthritis and related disorders is estimated at 3.6 billion dollars annually. No price tags, however, can be placed on the untold suffering, pain, invalidism, and mental anguish which these disorders impose on individuals and their families.

The conditions most often found are rheumatoid arthritis, gout, and osteoarthritis. All three are associated with adverse changes in metabolism. Rheumatoid arthritis is the most painful and the most crippling. It may attack any age group, particularly women (Table 16). It is a chronic inflammatory disease primarily of the connective tissue, that affects the entire body. No dietary deficiency has been causally related to rheumatoid arthritis, but as in any chronic, progressive disorder, good nutrition of the individual is of fundamental importance. Recently the possibility has been raised that metabolism of the amino acid histidine may be involved. Persons with rheumatoid arthritis have a negative nitrogen and calcium balance. To control the progress of this disease, it is important to enhance protein and calcium ingestion. While diet will not change the course of the disease, it does lessen the effects. No information is available relating the effect of adequate nitrogen and calcium intake in early life to incidence of rheumatoid arthritis.

Gout is usually an inherited condition and is associated with the absence of an enzyme necessary in purine metabolism and of a urate-binding protein in the blood plasma. Diets low in purines help to alleviate the adverse effects.

Osteoarthritis occurs primarily with advancing age and is a degenerative condition of the joints. The structure of the cartilage is affected. The cause of osteoarthritis is not known. Heredity and diet are believed to be underlying factors.

All of the arthritic conditions appear to be associated with adverse changes in nutrient metabolism. The dietary changes needed to prevent or modify the severity of the arthritic condition are not known. There is a good possibility that research on the special nutrient requirements and food needs of persons predisposed to arthritis would yield great benefit to those likely to be afflicted. It has been suggested that drug control of the pain could increase the active lifespan of arthritics by one to five years. It is reasonable to expect that improved diet practices could extend the active lifespan by as much as two years.

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TABLE 16

Arthritis in adults--number and rate, by sex and by age groups: 1960-1962[1]

Item	Total 18-79	Years 18-24	25-34	35-44	45-54	55-64	65-74	75-79
Rheumatoid arthritis								
Number of adults (thousands)	3,591	39	71	314	633	988	1,026	540
Rate per 100 adults								
Male	1.7	0.2	-	0.5	1.5	4.2	3.1	14.1
Female	4.6	0.3	0.6	2.1	4.4	8.3	14.1	23.5
Osteoarthritis								
Number of adults (thousands)	40,481	646	2,093	5,842	9,590	10,848	9,013	2,449
Rate per 100 adults								
Male	37.4	7.2	13.6	30.2	47.0	63.2	75.8	80.9
Female	37.3	1.6	6.2	19.6	46.3	75.2	84.7	89.8

- Represents zero.

[1](Excludes Alaska and Hawaii.) Units are annual averages based on direct examination from October 1959 to December 1962. Refers to civilian noninstitutional population ages 18 to 79 years.

Source: National Center for Health Statistics 1966 PHS publ. 1000, series 11, nos. 15 and 17. U. S. Dept. of Health, Education, and Welfare.

Diet serves three major roles in the maintenance of good dental health. Adequate nutrition is essential for the proper development of tooth structure before eruption and later for the maintenance of a firm, healthy tooth surface and resistance to the cariogenic organisms in the mouth. These microorganisms are generally accepted as responsible for conversion of sugars to acids in the mouth, the latter dissolving the calcium in the tooth to form the hole. Some sugars have very high cariogenicity, for example, sucrose. Other sugars (and starches) have very low cariogenicity. The presence of sucrose, especially the sticky sweets eaten between meals, encourages the increase in numbers of cariogenic organisms. A change in food habits is necessary to make this means of control effective.

The third critical area for diet in dental health is in the maintenance of healthy gums and teeth in adults to prevent or modify the onset of periodontal disease. The Health Examination Survey, conducted during 1960-62 by the U. S. Department of Health, Education, and Welfare, estimated that about 44 million adults, age 18 to 78 years had gingivitis, and about 23 million had chronic destructive disease indicative of advanced periodontal disease. Both dental caries and periodontal disease also are influenced by a number of nonnutritional factors, particularly oral hygiene.

An examination of the economics of health services in the U. S. indicates that the consumer spends one-seventh to one-ninth of his health dollar for dental health services, a total of about 3 billion dollars in 1966. This cost represents the 20 percent of the population estimated to receive adequate dental care during the calendar year. At that rate, care for the total population of the country would have approached 15 billion dollars or 2 percent of the country's gross national product. The size of the dental health problem is reflected in the fact that in 1957 there were 22 million persons in the U. S. who had no natural teeth. This is equivalent to one out of every eight persons. Loss of teeth increases progressively with age and half of all persons past the age of 55 years have no natural teeth. Over 98 percent of the U. S. population is afflicted with dental decay, and the proportion is rising. Dental caries without proper dental services and hygiene are the main cause of the problems. The preventive role of proper diet is not clearly established.

The influence of nutrition in dental health begins before birth. Fluoride taken by the pregnant mother and passed in limited amounts through the placenta to the fetus makes the child's teeth significantly more resistant to dental caries. Many changes in oral structures of experimental animals have been reported in relation

to prenatal nutrition. These include basic changes in the dento-facial pattern ranging from minor abnormalities to cleft palate and harelip; changes in size and shape of both molars and incisor teeth; delay in eruption of molars; and an association with increased dental caries. A deficiency or an excess of a nutritional factor normally required, or an antagonist which can disrupt the normal metabolic process may interfere with embryonic development. Some of the nutritional factors which have been associated with these changes include riboflavin, folic acid, and their antimetabolites; vitamin A; and diets high in sugar or phosphate. Each factor tends to be involved in a characteristic pattern of effects which are not necessarily limited to the oral structures. Changes in the maternal diet can affect the fetus without being detrimental to the mother. The mechanism of this nutritional influence appears to result in the death of the cell or in alteration in the rate of cell growth.

Clear-cut cause and effect relationships between nutrition and periodontal disease have not been established. Gingival inflammation can be induced by nutritionally inadequate diets. Healing of existing lesions has been delayed by protein-deficient diets. Also, the morphology of the dental plaque closely associated with the presence of periodontal disease can be varied by alterations in the composition of the diet.

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Problems of carbohydrate metabolism, including reduced glucose tolerance and intolerance to certain disaccharides affect a large proportion of the adult population. Severely reduced glucose tolerance, resulting from the inability of the body to efficiently utilize glucose is commonly referred to as diabetes mellitus. Less severe reduction in glucose tolerance does exist unrecognized in large numbers of persons. The diabetic population is increasing. Diabetes stood seventh among the causes of death in the U. S. in 1969 accounting for over 35,000 deaths. Over 4 million diabetics were estimated in the U.S.A. in 1967. There are an additional 5,600,000 potentially diabetic persons. Thus, one in twenty has diabetes or is potentially diabetic. Nearly seven out of ten known persons with diabetes had their diabetes discovered at age forty-five years or older.

In diabetes, the body is unable to metabolize carbohydrates normally, being unable to convert carbohydrates into the stored form, glycogen, or to utilize them for the energy required for normal body functions. Glucose disappears from the bloodstream at a slower than normal rate following carbohydrate intake. The condition is associated with deficiency or inadequate utilization of insulin. As the disease progresses, abnormal carbohydrate metabolism becomes associated with a derangement in the metabolism of fats and proteins. Health conditions associated with diabetes are extreme tiredness, leg pain, eye trouble, sudden weakness, frequent urination, thirst, itching, loss of weight, changes in appetite, and degenerative vascular disease.

Diabetes has been known for some time to be a hereditary disorder which can be controlled by insulin therapy and diet management. During the past decade, the trace mineral chromium has been shown to improve the body's ability to use carbohydrate, particularly when the reduction in glucose tolerance is associated with aging. It has been postulated that the decreasing ability to handle glucose with age may reflect chronic marginal intake of chromium throughout life. It is known that the original content of chromium or its biologically available form, as of other trace elements, is markedly reduced by refining and processing of foods. U. S. Public Health Service studies have suggested that as many as 14 percent of the U. S. population may have reduced glucose tolerance. A recent study in 1965 found that 77 percent of "normal" subjects over 70 years of age have abnormal glucose tolerance. The reduced glucose tolerance, a characteristic of the aging process, has been associated with increased incidence of coronary heart disease and stroke (HEART, Fig. 13).

Blood sugar levels increase with age (Table 17). Evidence of reduced glucose tolerance is apparent before age 30 years. This reduction in glucose tolerance may result from aging, a high prevalence of diabetes-related genes or, as recently suggested, a reduction in body chromium stores resulting from a chronic marginal intake during the lifetime. Women tend to have a slightly higher blood sugar level than men. The tendency increases with succeeding pregnancies and may be due to decreased body stores of trace elements such as chromium.

Considerable attention is now being given to the significance of lactose intolerance in nutritional problems in the U. S. Lactose is the principal sugar naturally occurring in milk. Normally, it is changed during digestion to glucose and galactose which are absorbed. In the adult, and occasionally in the infant, not enough lactase is produced to break down the lactose. In these "lactose intolerant" individuals, the sugar passes into the intestine where it is acted on by microorganisms with the production of gas and accompanying discomfort from diarrhea and intestinal distension. The incidence of lactose intolerance in healthy adults is shown in Table 18. As many as 19 percent of adult Caucasians, 74 percent of Negroes and 95 percent of Orientals in the U. S. may be affected.

Persons who are unable to metabolize lactose find it necessary to exclude milk and many milk products from their diets. Milk is a major dietary source of calcium. Diets without milk frequently contain less of this important mineral than is recommended by the Food and Nutrition Board of the National Research Council. This is particularly important in evaluating and improving the diets of low income families. About three-quarters of the black adults in this group probably cannot consume milk without distress. About 45% of Negro school children in Baltimore, Maryland, had a reduced ability to metabolize milk sugar. Milk given with the school lunch was more likely to be rejected by these children even though small amounts of milk could be consumed without major discomfort.

Monosaccharides also may present a metabolic problem. An inborn error in the metabolism of galactose results in abnormally large amounts of this sugar in the blood. The condition is characterized by nutritional defects, mental and physical retardation, enlargement of liver and spleen, osteoporosis, and cataracts. Eyesight is frequently affected.

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TABLE 17

Mean blood glucose[1] in adults
Health examination survey, 1960-1962

Age (years)	Mean glucose in mg % Males	Females
18-24	96.5	104.6
25-34	101.2	110.0
35-44	113.5	119.9
45-54	118.8	132.7
55-64	131.8	144.8
65-74	137.9	157.8
75-79	151.6	173.3

[1]Excludes persons with diagnosed diabetes and pregnant women. Blood glucose measured 1 hour after ingesting 50 grams of glucose without regard to time or content of previous meal.

Source: National Center for Health Statistics 1966 PHS publ. 1000, series 11, no. 21. U. S. Dept. of Health, Education, and Welfare.

COMMENT: BLOOD SUGAR LEVELS INCREASE WITH AGE. WOMEN TEND TO HAVE A SLIGHTLY HIGH BLOOD SUGAR LEVEL THAN MEN. GLUCOSE LEVELS FOR WHITE AND NEGRO POPULATIONS DID NOT APPEAR TO DIFFER. HAVING CHILDREN WAS NOT, IN GENERAL, ASSOCIATED WITH HIGHER BLOOD GLUCOSE LEVELS.

TABLE 18

Lactose intolerance in "healthy" adults

Group	Number studied	Lactose intolerant (percent)		
		By symptoms	By blood sugar	By lactase assay
Caucasians (U.S., Great Britain, Australia) (several studies combined)	217	17	19	15
Black, U.S.A. (several studies combined)	107	63	74	73
Black, Central Africa, various countries	16	50	88	--
Black, Bantu, various tribes	66	40	59	70
Black, Hamitic tribes	10	--	0	--
Oriental, U.S.A.	31	70	95	100
Oriental, Australia	20	95	85	--
Oriental, India	18	22	22	11
Oriental, Thailand	215	88	97	95
Australian aborigine	19	--	79	--
North American Indian	3	--	67	--
South American Indian (Colombia)	24	58	100	--
South American Mestizo and Antioqueno	"many"	"high"	"high"	--
Greek Cypriot	17	--	88	--
North African Arab	3	67	100	--

Source: Lutwak, L. 1970 The significance of lactose intolerance in nutritional problems. Eastern Experiment Station Collaborators' Conference on Human Nutrition, October 28, 1969. ARS 73-67. U. S. Dept. of Agriculture.

OSTEOPOROSIS

Osteoporosis is a disease of the bone characterized by increased porosity and softness in which the amount and strength of the tissue has been decreased. The bones are susceptible to fracture, and in severe cases of osteoporosis, under normal mechanical stress. It is one of the most common and yet least understood afflictions of bone. It occurs during middle or old age and is observed more frequently in women than in men. Osteoporosis is one of the major causes of disability in age. The spine is affected first. Thinned by disease, the bones of the spine are compressed by body weight resulting in low back pain, back deformity, loss of weight and the capacity for physical activity.

The significance of the disease as a basis of vulnerability to fracture and disablement is of real or potential importance to millions of persons over 40 throughout the world. Recent surveys indicate that osteoporosis is more widespread than arthritis and about three times as common as diabetes. Using the severe criterion of vertebral compression, these surveys suggest that approximately 25 to 30 percent of women and 15 to 20 percent of men over the age of 50 have osteoporosis of this high degree. An extensive study of osteoporosis in 2,000 women of Puerto Rico and Michigan indicated that nearly 50 percent of women over 45 years and 80 percent of women over 65 have "significant vertebral atrophy."

Disturbances in protein, mineral, or hormonal aspects of bone metabolism have been implicated as causative factors which lead to increased resorption of bone. The rate of bone resorption is twice normal in osteoporosis while the rate of bone formation is about normal. Dietary calcium, phosphate, vitamin D, fluoride, and possibly magnesium are thought most likely to be involved. A study is being undertaken at Cornell University of 50-100 individuals with "early osteoporosis" defined as bone density significantly below the mean for age and sex. The effectiveness of therapeutic dietary regimens including the nutrients noted above will be evaluated. The individuals for intensive study will be selected after a survey of about 2,000 individuals in the general population for subclinical osteoporosis.

Some investigators have suggested that primary osteoporosis could be the result of a prolonged chronic submarginal intake of calcium. These investigators also conclude that unless supplemented by milk or calcium therapy, the diet presently selected by the geriatric population in the U. S. is generally deficient in calcium. This premise is supported by the findings from the Nationwide Diet Survey in 1965. Defective mineral absorption from the intestine, excessive

calcium excretion, and physical inactivity may be contributing factors. Osteoporosis is generally considered a physiological characteristic of deterioration with age. Its relation to nutritional state is generally recognized. There is insufficient information at this time to identify what dietary control is necessary to defer, modify, or avoid the onset of this condition. However, nutritionally induced osteoporosis in dogs was recently demonstrated, lending increased credence to fragmentary data on human subjects, indicating that proper diet can prevent or alter the course of osteoporosis in man.

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Obesity is a prevalent health problem, at every age, in both sexes, and at every economic level in the U. S. today. Precisely how prevalent is difficult to assess, and there are no exact statistics. Almost 3 million adolescents (10 percent) in the U. S. are estimated to be seriously ill with overweight. In adults, the percentage of persons above their best weight is considerably higher (Table 19). A person is generally considered to be obese if he weighs more than 20 percent above the average for his age and height. Obesity is more prevalent in women than in men and is more likely to occur as age increases. The greatest increase in weight occurs in the 20 to 30 age group. About 60 to 70 percent of men and women over 40 years are above their best weight.

Obesity and overweight are not considered to be a cause of death; however, they are closely associated with increased mortality from other conditions (Fig. 20). Insurance statistics reveal that overweight people are more likely to develop certain diseases and to die at a younger age than people of normal weight. Diseases such as diabetes mellitus, gall bladder disease, gout, kidney and digestive diseases, hypertension, and possibly coronary heart disease are significantly associated with obesity (Figs. 21,22). Obesity increases surgical risk; is a hazard in pregnancy; prevents ambulation and self care in arthritis and fractures of the lower extremities in the aged; places a greater load on the heart and circulatory system; and increases the work in breathing. Reduction in weight to normal levels increases the likelihood of success in treating these health conditions. Weight reduction alone is not a cure, but it may modify the condition so that it is no longer critical. In addition to health problems, there are a number of social and psychological consequences arising from obesity. Good nutrition and maintenance of normal weight may prevent many health conditions from becoming debilitating.

There has been considerable research on various aspects of the causes of obesity, the nature of the disorder, and its treatment. Obesity is not a disease entity as such but a symptom of some underlying difficulty which may have many causes. A number of diverse factors are indicated: genetic, physiologic, psychologic, and social economic influences contribute to the development and perpetuation of the condition. Culture, activity, food habits, and way of life, all are involved.

So far, no successful long-term treatment of obesity has been found. The direct cause of obesity is the consumption of more calories than needed to provide the energy needs of the individual (Fig. 23). Obese children and adolescents are more likely to remain obese as adults and to have difficulty in losing fat and maintaining fat loss. A longitudinal study of obese children showed that 86 percent of the men and 80 percent of the women who were overweight as children were overweight as adults. This has been shown to occur in developing countries where the incidence and severity of undernutrition is high. It probably is a factor in the high incidence of obesity in low income families in the U. S.

Malnutrition during pregnancy and early life may be reflected in obesity in adulthood. The total number of cells in the body are determined during the prenatal period, infancy, and early childhood. Later periods of growth in adulthood influence the size of the cells rather than the total number. Poor nutrition and undernutrition during the period of cell formation means that the adult will have fewer cells to carry on body processes and store fat. Malnourished children are likely to be obese adults, because fewer cells are available to the body for fat storage. Even though their height-weight ratio is close to average, these individuals have a lower proportional protein and higher fat content in their body mass than do well nourished people. Overfeeding early in life may establish metabolic pathways which predispose to adult obesity.

A very important factor in the development of obesity is the amount of exercise. The periods of rapid growth and high activity during adolescence are accompanied by high caloric requirements. When calorie needs are less, excess calories are retained as fat unless diet is adjusted. This should be a normal process regulated by appetite. When this does not occur, body fat increases over a period of time leading to obesity.

The wide variation in the efficiency with which people use calories suggests that heredity is also a factor in obesity. Studies of obese and normal adolescents and young adults show that the nonobese individual tends to burn up rather than store excess calories in short-term dietary excesses while the obese individual stores them as fat. Obese persons also are less likely to mobilize body fat to meet short-range calorie deficits than the nonobese. In addition, some persons convert carbohydrate to fat at an increased rate.

Food habits are important in both the development and control of obesity. Traditional and family eating and cultural patterns are often conducive to overeating and obesity and contributes to the high incidence of obesity in some families. Food preferences may be established as early as three years of age. Because food provides so many satisfactions besides nutritional needs, bad habits are not easy to change. The difficulty in making permanent adjustments in living patterns is one of the main reasons for lack of success in weight reduction by regulation of diet.

There are many economic costs arising from obesity and overweight, including the greater likelihood of early death and lost productivity. In addition, there are direct costs to the individual such as increased insurance premiums. Costs due to increased likelihood of developing certain diseases have been included elsewhere in the cost of those health conditions. Obese persons tend to be inactive and lethargic which may result in a reduced work efficiency.

The social costs of obesity are less easy to identify and gratify. Obese individuals are less attractive and are less readily accepted in the community. They are at a disadvantage in employment because of lesser agility, and they create a poor image in their relationships with other persons. Because of these factors and the greater likelihood of developing debilitating health conditions, obesity is frequently a handicap to career advancement.

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TABLE 19

Percentage of persons deviating from best weight[1]

Age (years)	Men		Women	
	10-19% above best weight	20% or more above best weight	10-19% above best weight	20% or more above best weight
20-29	19	12	11	12
30-39	28	25	16	25
40-49	28	32	19	40
50-59	29	34	21	46
60-69	28	29	23	45

[1]Adapted from Metropolitan Life Insurance Co., New York. Frequency of overweight and underweight, Statistical Bulletin 41(4): January 1960.

Source: National Center for Chronic Disease Control 1966 Public Health Service publ. 1485. U. S. Dept. of Health, Education, and Welfare.

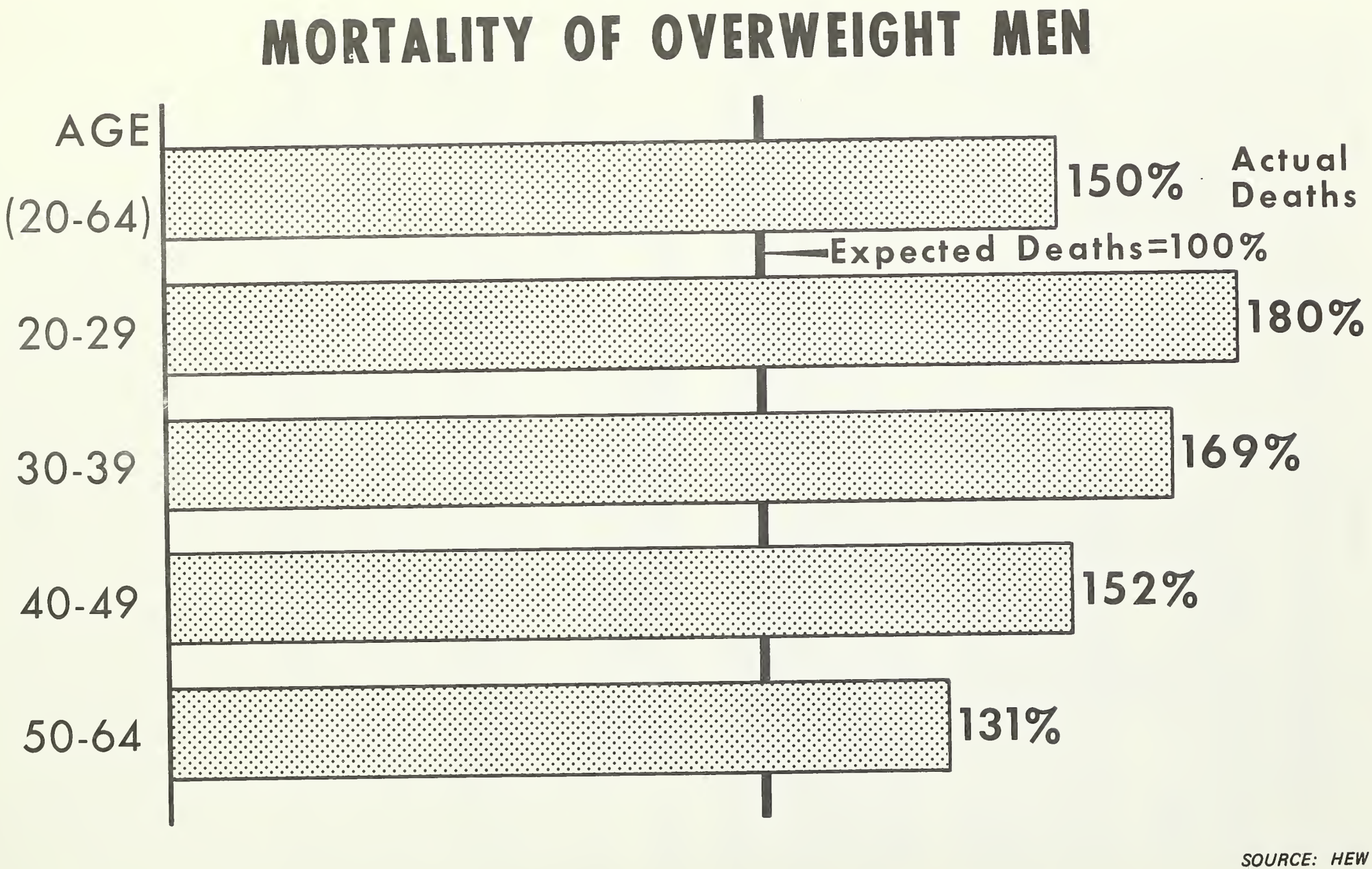

Figure 20. — A marked increase in mortality occurred in all age groups of overweight men. However, these mortality figures represent only the first 14 percent of deaths in the group studied. The worst mortality record is apparent in the younger age groups (20-29 years).

MORTALITY OF MEN

By Build and Cause of Death, Ages 15-69

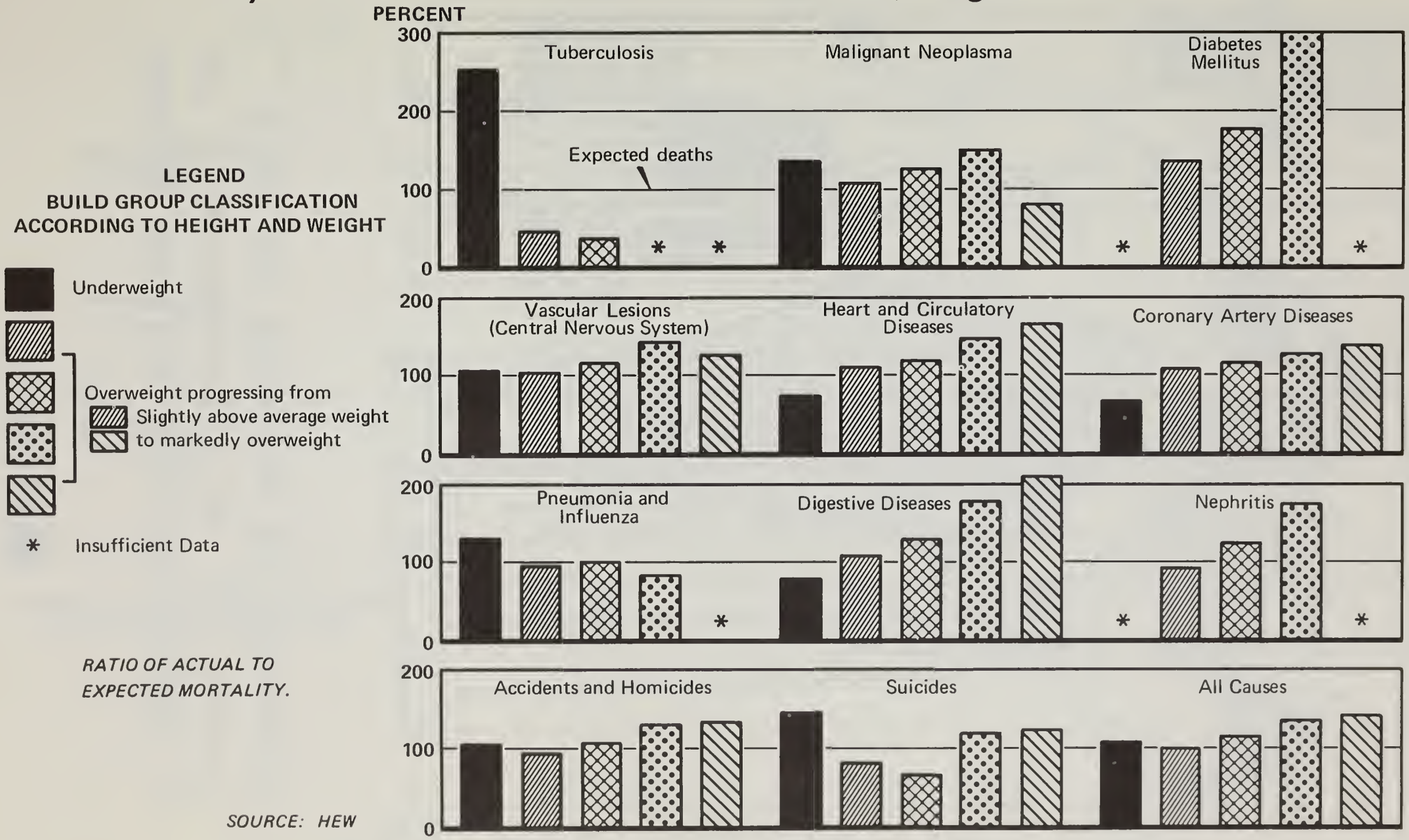

Figure 21. — An increase in weight is associated with a high mortality from all causes. The increase in deaths is largely attributable to diabetes, heart and circulatory diseases, digestive diseases and nephritis. The degree of overweight is directly related to higher mortality rate.

MORTALITY OF WOMEN

By Build and Cause of Death, Ages 15–69

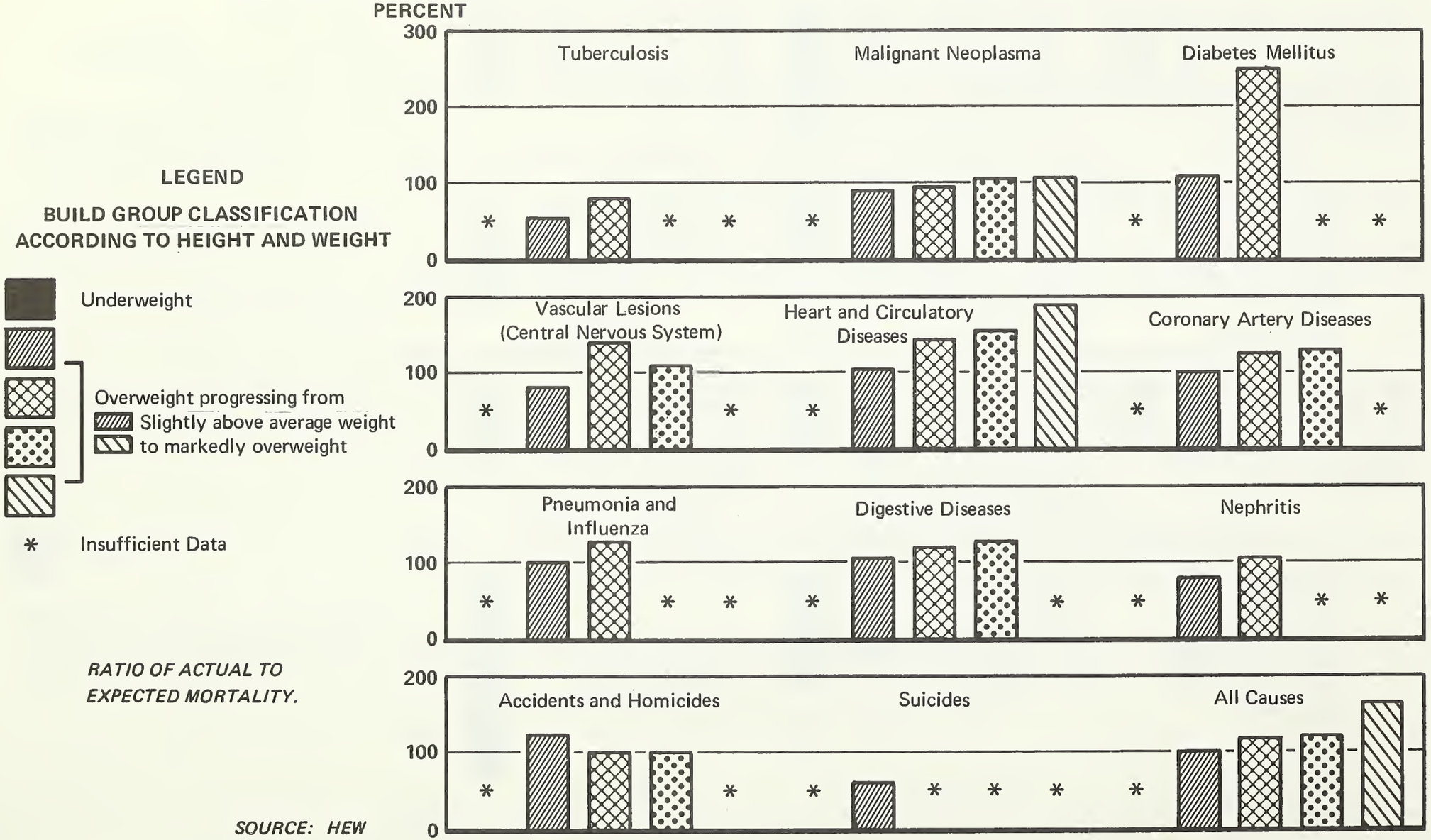

Figure 22

" You've gained 10 pounds in 6 months!!...In 30 years you'll weigh 770 pounds ."

Figure 23

Gross clinical occurrence of nutrient-deficiency diseases other than anemia rarely occurs in the U. S. There has been little documentation of subclinical deficiencies, because there are no specific and rapid procedures available for their identification. The Nationwide House-Hold Food Consumption Survey of 1965 indicated that some nutrients in the diets of certain sex-age groups were below the 1968 NAS-NRC Recommended Dietary Allowances. This survey provided a means for identifying population groups which need immediate special attention. People having low incomes are more likely to have poor diets (Fig. 24), but malnutrition is found in affluent groups as well.

The National Nutrition Survey begun by the U. S. Department of Health, Education, and Welfare in 1968 has been confined largely to low income families and indicates some deficiencies apparent on clinical examination. Iron, vitamins A, B_1, B_2, C and folacin were the major nutrient deficits. There was also a low incidence, 3-1/2 percent, of retarded growth. A number of deficiencies have been identified by the biochemical data from the survey. In Texas, 41 percent of the individuals surveyed had unacceptable levels of serum vitamin A while the Louisiana survey had 15 percent. Over 60 percent of adolescents and children had unacceptable levels. The prevalence was much lower for adults. Twelve percent of the people surveyed in Texas and 14 percent in Louisiana had unacceptable serum levels of vitamin C. Thiamine and riboflavin nutriture was unacceptable in 10 percent and 16-21 percent of the surveyed people respectively. Some preliminary results from the Louisiana portion of the study are given in Table 20.

Nutritional anemia is one of the most widely occurring deficiencies. These anemias are most likely to develop during periods of rapid growth, such as infancy and adolescence, and during the childbearing years in women. During these stress periods, it is difficult to select diets to meet the increased needs for iron. Anemia due to iron deficiency is presently recognized as the most common type of nutritional anemia. Folic acid, vitamin B_{12}, and protein often are involved. There is not complete agreement on the significance of anemia in terms of health. Anemia is common in infants, 12 to 24 months of age, regardless of family income. More than two-thirds of ghetto children in this age range may be affected. These infants appear normal in other respects. However, anemia adds to the incidence and seriousness of other health hazards such as fevers. Anemia is also detrimental to learning ability (IMPROVED LEARNING ABILITY).

There is good evidence that folic acid deficiency may be a real problem in the U. S. Megaloblastic anemia associated with folate deficiency is frequently found during pregnancy, particularly in mothers from low income families. Apart from this, folate deficiency may be widespread among the poor, the alcoholics, and the cirrhotics. A 1965 report of a municipal hospital in Jersey City suggested that folate deficiency is the commonest form of hypovitaminemia to be found in the sick and injured. Green vegetables are a major source of folic acid. If a poor family is able to grow vegetables, the members are not likely to suffer from folate deficiency. The population shift from rural to urban and the decreasing consumption of green vegetables may be reflected in the increased incidence of folate related anemia. Any condition resulting in an increased need for blood formation will increase the needs for dietary folic acid. Available knowledge of the requirements for folate is not conclusive. The requirement is thought to be from 50 to 200 micrograms daily. It is difficult to predict whether there may be folate deficiency from dietary studies because of inaccurate and insufficient data on folic acid content in foods. Present methodology does not indicate folate actually available for human nutritional requirements.

Vitamin A and vitamin D may also be insufficient, particularly in the diets of children up to 8 to 10 years of age. The incidence of rickets was higher than expected in the National Nutrition Survey. Serum levels of vitamin A were below acceptable levels in about 40 percent of the children under 17 years studied in Louisiana (Table 21). Income level was a minor factor. The situation with regard to vitamin A may be even worse than indicated by these data because of recent findings that the acceptable level for serum vitamin A may be higher than the survey criteria.

It is important to recognize that individuals vary in the amount of nutrients needed, and that some cases, clinical and biochemical deficiencies may appear in spite of a diet which would be adequate for most persons. Very little is known of the upper limits of nutrient requirement or the incidence of persons having unusually high needs.

There may be a number of chronic dietary deficiencies which have not been identified. Some of these may be trace elements which have been provided in the past in adequate amounts, or nearly so, by diet. Changes in food technology, including formulation of foods, may result in chronic marginal intakes of some nutrients with the development of subclinical deficiencies not recognized at this time as nutritionally caused.

Among the nutrients likely to be deficient in certain areas of the country and segments of the population are cobalt, copper, chromium, and iodine. Selenium and molybdenum may occur in toxic amounts in some regions of the U. S. (Fig. 25). For decades, the need to add iodine to the diet in some areas has been recognized. More recently, there has been a reduced consumption of iodized salt, probably because changed technology and processing may require the use of noniodized salt.

Changes in environment also may contribute to the problem of excesses. For example, the fertilization of the soil may increase the nitrate and cadmium levels to the point where the foods produced may contain high enough levels of these nutrients to be adverse in infant feeding. Increasing levels of lead, carbon dioxide, and ozone in highly populated areas may stress individuals consuming diets borderline in nutrients.

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U.S. DIETS WITH NUTRIENTS LESS THAN RECOMMENDED DIETARY ALLOWANCES▲

SEX—AGE (YEARS)	PROTEIN	CALCIUM	IRON	VITAMIN A VALUE	THIAMINE	RIBO-FLAVIN	ASCORBIC ACID
MALE AND FEMALE:							
UNDER 1			* * * *				o o o
1-2			* * * *				o o
3-5		o	* *				o o o
6-8		o o	o	o	o		o
MALE:							
9-11		* o o			o		
12-14		* * o o	* * *		* o		
15-17		* o o	* o		o		o o
18-19		o o o					
20-34							
35-54		*					o
55-64		* *					o o o
65-74		* *				o	o
75 & OVER		* * * o		*		* * o	* o o o
FEMALE:							
9-11		* * * o	* * * *		*		
12-14		* * * o	* * * *	* o o	* o		
15-17		* * * *	* * * *		* *		o o
18-19		* * * o	* * * *	*	* o	o o	o o o
20-34		* * * o	* * * *		*	*	o o
35-54		* * * *	* * * *	o o o	*	* *	o o
55-64		* * * *		o o	* o	* o	o o
65-74		* * * *	*	*	* *	* *	o
75 & OVER		* * * *	* o	* *	* * o	* * *	o o

1 SYMBOL — 1-10% 2 SYMBOLS — 11-20% 3 SYMBOLS — 21-29% 4 SYMBOLS — 30-58%

**INCIDENCE FOR ALL INCOMES °ADDITIONAL INCIDENCE FOR INCOMES UNDER $3,000 ▲NAS-NRC, 1958*

DIETS OF MEN, WOMEN, AND CHILDREN, 1 DAY IN SPRING, 1955

Figure 24

TABLE 20

Nutritional status by age group[1]

	Percent with less than adequate levels				
	Age group (years)				
	0-6	7-17	18-59	60+	Total
	%	%	%	%	
Plasma vitamin C	9	10	11	17	14
Plasma vitamin A	43	40	2	1	26
Hemoglobin males	39	37	45	57	--

[1]Preliminary results based on 3,346 individuals.

Source: Unglaub, W. 1968-69 National Nutrition Survey, Louisiana data, unpublished.

TABLE 21

National nutrition survey, Louisiana, 1968-1969
preliminary results for plasma vitamin A

Age (years)	Number of persons	Unacceptable values
		%
0-6	642	45
7-17	1,200	40
18-59	1,092	2
Over 60	412	1
Total	3,346	25

Income level	Unacceptable values	
	Males	Females
	%	%
Poverty	37	28
Above poverty	20	17

Source: Unglaub, W. 1968-69 National Nutrition Survey, Louisiana data, unpublished.

LEVELS OF MINERALS IN SOILS

Regional Differences

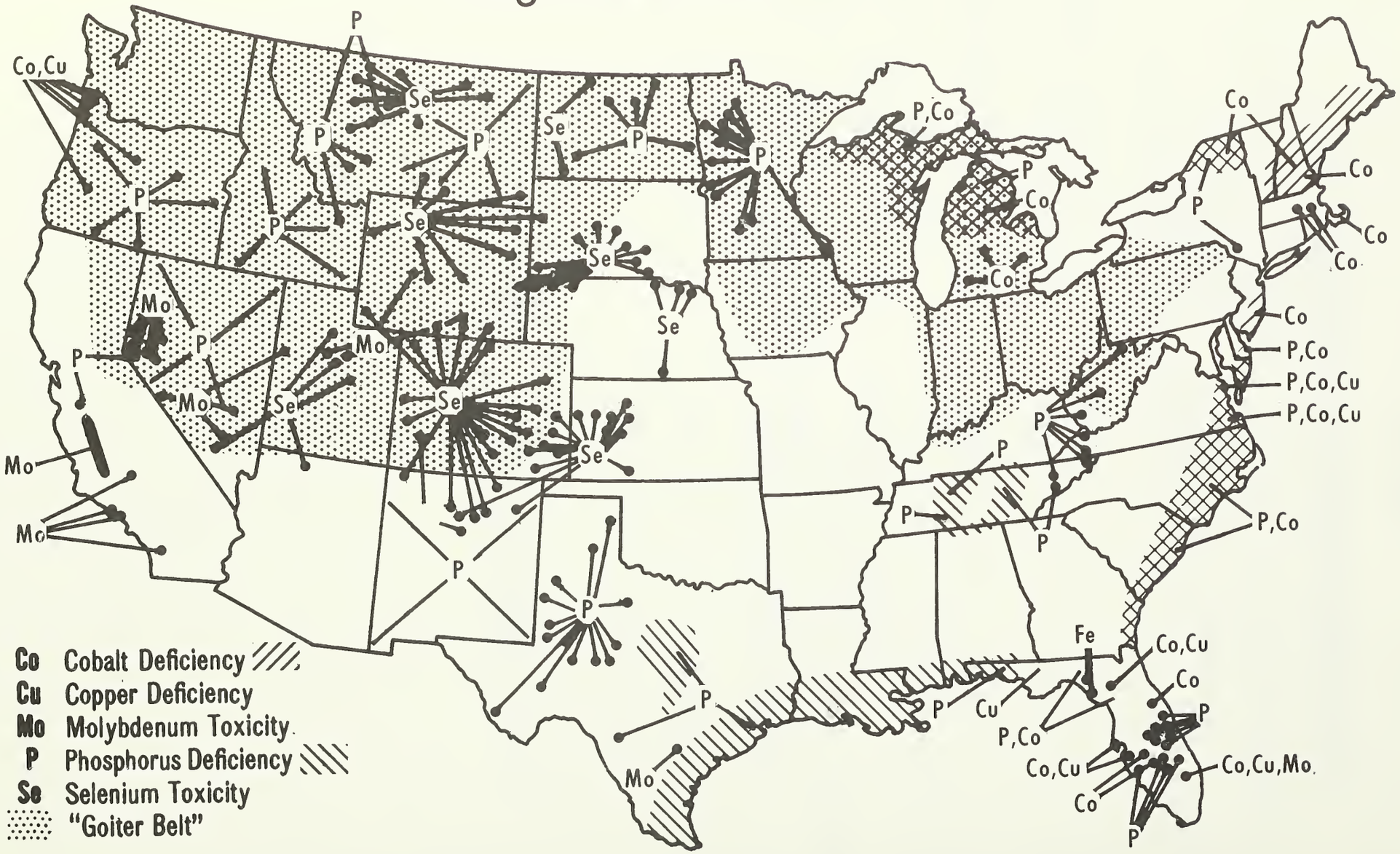

Figure 25

Alcoholism is a metabolic disease associated with social and physiological stress. According to the National Council on Alcoholism, 5 million alcoholics live in the U. S. This estimate is for 1970. Firm figures for incidence are not available because many alcoholics, particularly women, are not identified. Alcoholism is occurring much more frequently among very young people. The incidence is high among the lower social and economic classes. Persons with a history of alcoholism have a death rate 2-1/2 to 3 times higher than standard risks. The National Council on Alcoholism estimates an annual loss to industry of over 2 billion dollars, resulting from absenteeism, lowered productivity, and accidents associated with alcoholism.

Good diet is an important factor in maintaining the productivity and health of alcoholics. It has generally been supposed that it is alcoholism, which is usually accompanied by a lack of interest in food, that leads to malnutrition. Not until recent months has poor diet been implicated as a cause. There is now some evidence with rats that a craving for alcohol can result from a chemical imbalance created by inadequate diet. Switching to a well-balanced diet was accompanied by a reduction in alcohol consumption.

Alcohol is a food contributing seven calories per gram of alcohol. It has been estimated that alcohol contributes 15-20 percent of the total caloric intake in U. S. diets. The alcoholic individual substitutes alcohol for much of the normal food intake and as a consequence the intake of proteins, minerals, and vitamins may be grossly deficient. About 50 percent of alcoholics have anemia due to hemorrhage, ulcers, or malnutrition. Many of the symptoms characteristic of alcoholics may be attributed to nutritional deficiencies rather than to toxicity of alcohol *per se*. Weakness, numbness, fatigue, and lack of interest typical of alcoholism also are characteristic of thiamine deficiency. When vitamin B_1 is supplied, many of the symptoms disappear. Skin conditions characteristic of pellagra are sometimes seen in alcoholics and may be reversed by increasing niacin intake. Lack of vitamin B_6 and pantothenic acid also may be responsible for neurological changes. A reduction in serum magnesium levels is occasionally seen in delirium tremors. Diets containing good quality protein and vitamins may help prevent many adverse changes in alcoholics and permit them to be gainfully employed.

Chronic intake of large amounts of alcohol is associated with the development of fatty liver and ultimately cirrhosis. In 1967, cirrhosis of the liver ranked eleventh as the leading cause of death accounting for almost 28,000 deaths. There has been a marked increase in the death rate from cirrhosis of the liver during the past decade (Fig. 26). Alcohol was the major factor in 88.5 percent of the deaths from cirrhosis

in Baltimore in the years 1957-58 and 1965-66. The increase in the death rate from cirrhosis was thought to reflect the improved control of tuberculosis since 1961. Prior to that date, many alcoholics died from tuberculosis before cirrhosis had progressed far enough to be fatal.

Nutrition has contributed significantly in alleviating the results of alcoholism. There are still many people who could benefit from existing knowledge who have not been reached. These are the persons whose condition has not reached the clinical stage. More help could be given if we understood better the factors responsible for fat deposition and mobilization in the liver. This knowledge is also fundamental to understanding the problems of obesity and of the undesirable changes in fat metabolism associated with heart and vasculatory disease. More complete knowledge of the mechanisms of fat metabolism is required before sound recommendations can be made for altering diets.

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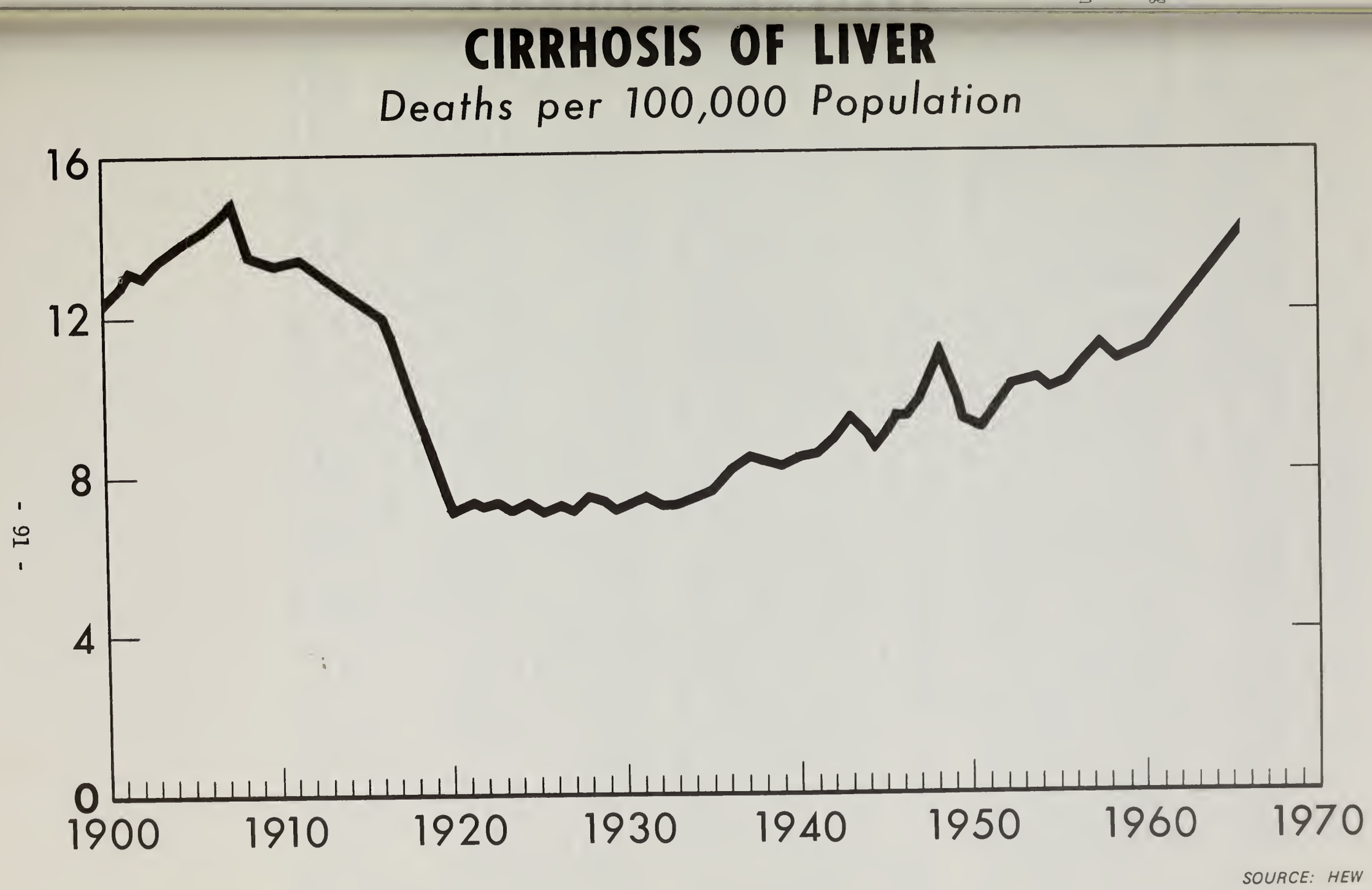
CIRRHOSIS OF LIVER
Deaths per 100,000 Population
16
12
8
4
0
1900
1910
1920
1930
1940
1950
1960
1970
SOURCE: HEW

Figure 26

The eye is particularly sensitive to nutritional inadequacy. Vision is one of man's most precious faculties. Good nutrition and intact vision are inextricably linked together throughout all phases of life. The eye as well as the brain has its most rapid rate of growth while the fetus is taking form and growing in the uterus. The eye continues to grow rapidly during most of the prenatal period and after birth commencing to slow in the third year of life. The eye increases in size hardly at all after age five. The brain-eye system is most vulnerable to the effects of deprivation of food during the early months and years of life. Some of the results of nutritional inadequacy during this early period do not become apparent until later in life when the eye is more susceptible to infection. Degenerative changes occur at an earlier age and progress to greater severity.

The social and economic costs of poor eyesight and blindness are great. Forty-eight percent of the U. S. population over three years of age wore corrective lenses in 1966 (Table 22). Included were over 8 million children, 15 percent, between the ages of 3 and 16 years and about 78 million or 88 percent of the population 45 years of age and over. In 1968, almost 81,000 blind persons received public assistance payments at an estimated cost in public assistance of over 103 million dollars. Statistics are not available on the number of persons who are partially or severely handicapped in their employment because of poor vision nor are the number of accidents which occur from this cause. About 81,000 persons become blind every year.

Lack of vitamin A is responsible for the most widespread form of blindness of nutritional origin in the world today. Insufficient vitamin A results in damage to the cornea. In its early stages, it is reversible if treatment is instituted in time. The disability changes in the eye take place only after a long period of deprivation of vitamins. The incidence of adverse eye changes due to vitamin A deficiency in the U. S. is not well documented. Recent developments indicate that vitamin A deficiency is much more common than predicted. A nationwide survey of household food consumption in 1965 indicated that 27 percent of all households consumed diets below the recommended daily allowance for vitamin A. More recent, preliminary results from the National Nutrition Survey begun in 1968 are showing that about 33 percent of children under five years of age and 29 percent of those aged six to nine years have blood vitamin A levels below that considered adequate (Fig. 27). In some areas about 40 percent of children up to

17 years of age had unacceptable plasma vitamin A levels (Table 21). About twice as many children in low income brackets had unacceptable vitamin A levels as in more affluent families. Of even greater concern are clinical observations made in Iowa where adverse changes in the eye indicative of vitamin A deficiency are being found in individuals having plasma vitamin A values twice as high as the level generally accepted as being satisfactory.

There are indications, not well documented, that myopia in children is probably due to malnutrition. The normal, well-developed young child is long sighted. If all goes well, the refractive state of the eye gradually arrives at adult status before school age. About one-half of U. S. children have less than 20/20 vision (Table 23). There is evidence that severe nutritional stress during the period of active growth may throw the delicate compensating mechanisms off balance and lead to myopia. Additional evidence comes from the observation that premature infants are much more myopic than full-term infants. Also, a recent study of 553 blind children born in New York State over a 12-year period revealed that many were of low birth weight indicative of poor nutrition during fetal development.

Deficiencies of the B-complex vitamins, thiamine, niacin, riboflavin, and vitamin B_{12} are associated with impaired vision. In some instances, adverse changes in vision thought to be due to vitamin A have responded to vitamin B therapy but not to additional vitamin A. The B vitamin deficiencies are more likely to be associated with deterioration of vision resulting from optic nerve degeneration. This condition is more often found in the adolescent school child or in young adults eating a monotonous poorly balanced diet. B vitamin deficiency also is likely after periods of calorie restriction, whether deliberate or involuntary. Dimness of vision from B vitamin deficiency may be recognized with greater frequency in the future as greater demands are placed on acuteness of vision by wider education and the need for more skilled labor.

Problems of eyesight also are associated with other diet based problems. It is not uncommon to find cataracts in diabetics and in galactosemia. The latter condition occurs as a result of the inability to metabolize galactose from milk sugar.

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TABLE 22

Persons wearing corrective lenses--1966

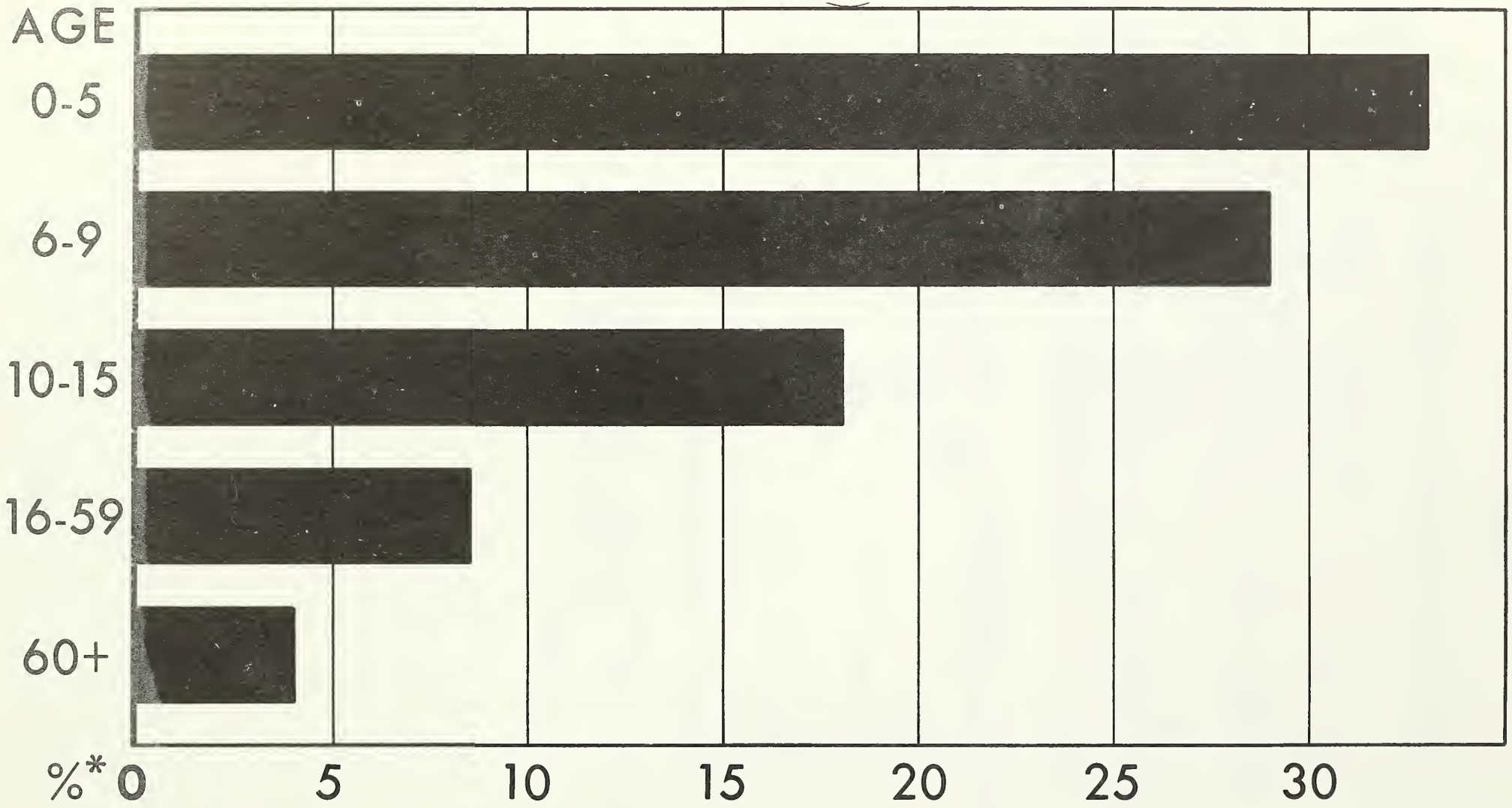
Sex and age (years)	Population, 3 years old and over	Total with lenses
Both sexes, total	178,907	86,020
3-16	55,037	8,263
17-44	67,579	28,224
45 and over	56,292	49,533
Male	86,195	36,880
Female	92,712	49,140
Both sexes, percent	100	48
3-16	100	15
17-44	100	42
45 and over	100	88
Male	100	43
Female	100	53

In thousands, except percent.

Source: National Center for Health Statistics 1967 PHS publ. 1000, series 10, no. 37. U. S. Dept. of Health, Education, and Welfare.

VITAMIN A DEFICIENCY

National Nutrition Survey, 1968



*% OF AGE GROUP WITH LESS THAN ADEQUATE LEVELS OF SERUM VITAMIN A

SOURCE: HEW

Figure 27. — Impaired vision results when body reserves of vitamin A are exhausted. Food consumption surveys show a continuing drop in consumption of dark green and yellow vegetables per capita. These foods are among the best sources of vitamin A and its precursors. Autopsy data indicate that liver stores in many people are nonexistent or marginal. Studies in Iowa lead us to believe that levels of serum vitamin A now accepted as satisfactory may be too low. There may be a much higher incidence of unacceptable vitamin A levels than this graph indicates.

TABLE 23

Proportion of children reaching visual acuity levels of 20/20 or better

Age (years)	United States 1963-65[1]	Private patients, Houston, Texas 1950[2]	School children, Toronto, Canada 1952[3]
	Percentage		
6	51	44	--
7	46	52	72
8	51	56	84
9	58	61	83
10	58	69	80
11	56	75	78

[1]U. S. Health Examination Survey 1963-65.

[2]Slataper, F. J. 1950 Age norms of refarction and vision. A.M.A. Arch. Ophth. 43(3): 466-481, March.

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Source: National Center for Health Statistics 1970 PHS publ. 1000, series 11, no. 101. U. S. Dept. of Health, Education, and Welfare.

COMMENT: DIFFERENCES IN RATES AMONG THE THREE STUDIES IS DUE IN PART TO DIFFERENCES IN THE PROCEDURES USED TO EVALUATE ACUITY. PROCEDURES ARE NOT STANDARDIZED.

A clear, soft, unblemished skin and glossy hair have long been considered indices of good health. Changes in the skin and hair are often the first indication of nutritional deficiency. The hair loses its glossy appearance, becomes rusty, and is easily plucked. The skin becomes dry, scaly, inelastic, and pallid in appearance. A brownish pigmentation appears in niacin and protein deficiencies.

Vitamins are the nutrients most often implicated in unhealthy appearance of hair and skin. The skin and hair changes associated with vitamin deficiency were characterized long before the nutritional origins of the conditions were recognized. Riboflavin, niacin, pyridoxine, and possibly pantothenic acid are the members of the B-complex group of vitamins that have clinical dermatological significance for man. Vitamins A and C also are involved. Changes in skin and hair appearance with age may be partially attributable to chronic marginal intakes of some of the vitamins. Pallor and skin changes are being found by Hodges and Sauberlich in ongoing studies with adults on vitamin A deficient diets.

Some skin disorders are accompanied by alteration of trace mineral metabolism. People with psoriasis, photodermatitis, radiodermatitis, and several forms of eczema frequently have increased nickel levels in the blood and often in the skin. The rate of healing from wounds and burns is increased by zinc supplementation. Those persons with prolonged healing problems often show low serum and hair zinc levels.

There are no statistics on the numbers of persons in the U. S. having adverse changes in the skin and hair because of nutritional deficiency nor of the extent to which improvement in appearance might be brought about by change of diet. Skin eruptions, loss of hair, scaliness or roughness of skin, and itching have been suggested to result from poor diet or nutrient insufficiency, but improvement from adding specific nutrients has not been demonstrated when diets are adequate. The potential for improvement lies in the number of individuals who consume diets containing less than recommended allowances for vitamins A, thiamine, riboflavin, and ascorbic acids. Women and young girls would be the most likely to benefit. Data from the National Nutritional Survey will provide biochemical and clinical evidence of vitamins A, C, B_1, and B_2 nutritional status. These data should provide a better base for estimating the number of persons likely to benefit from diet improvement.

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The actual incidence of food allergy is difficult to determine. Estimates are controversial because a large number of persons suspected of having food allergies have not been identified. Estimates, derived from answers provided by 20 practicing allergists over a two-year period, are that 22 million people are allergic. Sixteen million of these have hay fever or asthma. Some allergists believe that food is frequently a cause of allergic symptoms. Most agree that the incidence seems greatest in infants. This is attributed to a physiologic, immunologic immaturity that decreases with age and to a tendency to absorb unaltered proteins. This is in line with recent studies of the development of biochemical and physiological systems in various organs of neonates and infants by Winick and others.

Allergy to food may show itself in a number of ways. Vomiting, colic, diarrhea, irritability, fatigue, edema, allergic rhinitis, and eczema are some of the symptoms. The most common sites of response to ingested allergens are the skin and the respiratory tract. The symptoms are not specific for any one food or allergy.

There are two distinct types of allergic reactions to foods. One is characterized by a rapid appearance of symptoms within minutes after the food is eaten. Foods that are common causes of the immediate type reaction are fish, seafood, berries, and nuts. The second is characterized by a delayed type of response and is less easy to diagnose. A number of hours or days may intervene between the ingestion of the food and the appearance of the symptoms. Cereal, milk, eggs, beef, whole potato, orange, pork, chocolate, or legumes may cause the delayed response. Examples are sprue and celiac disease caused by intestinal sensitivity to gliadin, a protein fraction of gluten found in wheat, rye, oats, and barley. About one person in one thousand is allergic to gluten.

In the delayed type reaction, the protein breakdown product which forms during the process of digestion may be the allergen. In the case of the immediate type response, it has been suggested that the actual allergen is whole protein. The incidence of reported milk allergy varies from three percent to six percent. This does not include cases of lactose intolerance. Nuts, fish, chocolate, peas, tomatoes, and corn have also caused allergic reactions in children when they have been included in the diet. Raw foods are more likely to cause allergy than cooked.

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The food we eat has an intimate relationship to the gastrointestinal tract, and it would be expected that diet would play an important part in the development and severity of gastrointestinal diseases. The diversity and magnitude of gastrointestinal disorders combine to place these diseases in a prominent position among the chronic infections occurring in man. Disorders resulting from infection or the inability to utilize certain food constituents, such as gluten and lactose, have been discussed elsewhere in this report. Among the better known disorders of the gastrointestinal tract are peptic ulcer, ileitis, ulcerative colitis, and cystic fibrosis.

Digestive diseases are widespread and are next to infectious and respiratory diseases in responsibility for work and school days lost. It is estimated that approximately 14 million Americans, or over seven percent of the U. S. population, now have or have had an ulcerative duodenum. Each day, it is estimated that 4,000 more individuals develop ulcers and every year about 10,000 persons die of peptic ulcer complications. The cost in terms of lost man hours and direct medical expenses due to peptic ulcer alone is estimated at 5 million dollars annually. In one recent year, direct expenditures for diseases of the digestive tract in the U. S. amounted to 4.2 billion.

Digestive diseases accounted for about one-eighth of the new cases of disability lasting more than a week in a 1963-64 study of Metropolitan Life Insurance Company employees. Women had a higher rate of disability from digestive diseases than men (Table 24). The incidence of disability rises rapidly with advance in age, especially for the men.

Peptic ulcer is probably the most common of the digestive diseases. Numerous attempts have been made to relate diet to the incidence of this disease. However, there is insufficient evidence to incriminate any single food or particular nutritional pattern. Most of the research on diet has related to therapy after the ulcer has been diagnosed, rather than the potential of good nutrition in preventing the development of the condition.

The increase in morbidity and mortality from liver disease since 1960 is greater than that from any other disease. It is the fifth most common cause of death in American males over 40 years of age. The death rate from cirrhosis for white males between 45 and 64 rose from 39.9 per 100,000 in 1959 to 52.7 in 1967. Increased drug and alcohol use and addiction are implicated.

The proper functioning of the liver is closely related to diet. The liver functions in the intraconversion of carbohydrates, fats, and proteins; in storage for certain nutrients, particularly sugars and certain vitamins; and in production of blood proteins, antibodies and enzymes necessary for digestion. Excessive accumulation of fat and cholesterol in the liver is considered an indication of an undesirable health state. The proportion and kinds of fats and carbohydrates in the diet are a major factor in controlling these accumulations. When the level of fat is excessive, cirrhosis is likely to result.

No single nutrient is identified as being more important than another in the maintenance of a healthy digestive system. Most nutrients have been shown to take an active part in the function of the cells of the gastrointestinal tract. Most recently, vitamin A has been shown to have a specific function.

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TABLE 24

Disability from diseases of the digestive system
Average annual incidence per 1,000

Cause of disability	Males, at ages 17-64	17-24	25-44	45-64
All causes	104.3	86.4	71.7	158.5
All diseases of the digestive system	18.5	8.9	13.7	28.1
Ulcers and other diseases of the stomach and duodenum	5.3	2.1	4.4	7.3
Hernia of the abdominal cavity	4.6	1.1	2.4	8.6
Diseases of the gallbladder	1.9	--	1.1	3.4
Appendicitis	1.8	3.0	2.0	1.3
Diarrhea and enteritis	1.8	2.5	1.4	2.2
Malignant neoplasms	0.4	--	0.1	0.8
Other digestive diseases	2.9	0.2	2.1	4.6

TABLE 24--continued

Cause of disability	Females, at ages 17-64	17-24	25-44	45-64
All causes	196.0	147.1	192.4	277.0
All diseases of the digestive system	20.4	16.4	19.8	27.4
Ulcers and other diseases of the stomach and duodenum	3.5	2.2	3.1	5.8
Hernia of the abdominal cavity	0.9	0.2	0.6	2.2
Diseases of the gallbladder	2.7	1.0	3.5	4.6
Appendicitis	2.8	4.8	1.7	0.8
Diarrhea and enteritis	6.3	5.2	7.4	7.2
Malignant neoplasms	0.3	--	--	0.9
Other digestive diseases	4.0	3.1	3.4	6.0

Personnel of the Metropolitan Life Insurance Company, 1963-64, exclusive of the Pacific Coast states and Canada. Cases lasting eight days or more. Benign tumors of the digestive system are not included.

Source: Metropolitan Life Insurance 1967 Disability for diseases of the digestive tract. Statistical Bull. 48: 10.

In kidney and urinary disorders, as in chronic disease in general, emphasis has been placed on therapeutic rather than preventive measures. Statistical data on incidence are inadequate with more known of mortality than morbidity. Kidney disease is difficult to diagnose. In many cases, renal disfunction is associated with other health problems such as cardiovascular disease, and many deaths from the combination of the two conditions are classified under cardiovascular disease. Today in the U. S. an estimated 55,000 individuals die each year of irreversible kidney failure.

Very little is known concerning the mechanisms of prevention and control of kidney disorders. Very few major illnesses fail to involve the kidneys. By selective excretion of certain substances and reabsorption of others, the kidneys play an important role in regulating the composition of blood and other body fluids. They continually process blood to eliminate harmful waste products of metabolism. When kidney function is impaired, diet regulation is critical to maintain life. The alternative is kidney dialysis or transplantation. Because the kidney is so closely related to nutrient metabolism in its function in disposing of metabolic waste, it would be reasonable to consider the role of diet and nutrition in preventing the development or in modifying the severity of kidney disease. Almost no attention has been given to this aspect of kidney disease, although it would benefit many more people at much less expense and inconvenience than the more drastic methods of transplant and dialysis.

A disturbance in mineral metabolism, particularly calcium, is the first nutrition-related function to appear in chronic renal failure. One of the problems arising is the production of kidney stones. The incidence of kidney stones may be as high as 9.47 persons per 10,000 population. Vitamin D, excessive dietary alkali, excessive dietary calcium, and vitamin A deficiency have all been implicated. Diets high in carbohydrates also may be conducive to stone formation. The incidence of calculi is greater when sucrose is the source of carbohydrate than when starch or dextrose are eaten. Starch produces fewer calculi than dextrose or sucrose. This has great significance in U. S. diets where there is a trend towards a decreasing consumption of starchy foods and an increase in the proportion of carbohydrate calories from sugars. This shift in recent years in U. S. diets may be conducive to an increased incidence of kidney stones.

Many researchers consider that the occurrence of urinary calculi falls into the general class of deficiency disease. The relation of diet to urinary calculi formation is unknown. Many of the same dietary factors may be involved as in the formation of kidney stones. Vitamin A deficiency has been suggested as a cause in animal studies but has not been demonstrated in human patients. Animal studies also suggest that pyridoxine deficiency may be a factor, particularly in relation to the magnesium and calcium content of the diet.

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Because most muscle disorders develop over a long period of time, and many are characterized by remissions and recurrences over a period of many years, data on the incidence of muscle disorders are inadequate. Nerve as well as muscle tissue is frequently involved. Many conditions are included in this category including muscle atrophy, muscle dystrophy, and multiple sclerosis. Very little is known about the underlying causes of the adverse muscle changes.

Many of the muscular dystrophies and atrophies are inherited traits. There are about 200,000 cases in the U. S. The conditions are characterized by a degeneration of muscle and connective tissue indicating the existence of a metabolic disorder. It is likely that diet therapy would assist in regulating the development and severity of the conditions. Limited preliminary data with chicks suggest that a biologically active material in some vegetable oils can cause regeneration of muscle in some cases.

Multiple sclerosis is primarily a disease of the nervous system involving the degeneration of the myelin sheath of nerves. Classic features include impairment of vision, loss of control of both voluntary and involuntary muscles, tremor, loss of balance and ataxia. There is wide variation in the incidence of multiple sclerosis among geographic areas. It is more common in the northern hemisphere except for Japan. Death rate from this cause in Montana, North Dakota, and in Nebraska was almost five times greater than in Georgia and Louisiana. Migrants from high risk to low risk zones carry with them a high risk of multiple sclerosis, even though the disease may not become apparent until 20 years after migration. Estimates of its incidence in the U. S. range from 70,000 to a quarter of a million persons. Numerous hypotheses, including dietary patterns, have been proposed to explain the geographic distribution. Although many patients have symptoms early in life, the diagnosis is rarely made before the age of twenty-one. Women have a higher prevalence of multiple sclerosis than do men. A low fat diet has been successful in controlling progress of the disease in some instances, especially if the diet is begun in the early stages of the disease.

Good nutrition is essential for good muscle development and maintenance. Undernutrition is associated with a reduced body muscle mass and a reduction in the ability of the existing muscle to do work. Muscle disorders caused by vitamin deficiencies, fortunately, are now rare. The weak muscles and relaxed ligaments associated with vitamin D

deficiency, rickets, are often correctable if found early and a therapeutic regimen of vitamin D and calcium is established. Also rare are the neuromuscular conditions pellagra and beri-beri associated with deficiencies of niacin and thiamine respectively. Sufficient vitamin E, either alone or in combination with minute amounts of selenium, causes regression of some nutritional deficiencies.

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Cancer is second only to diseases of the heart and blood vessels as a cause of death in the U. S. In 1968, approximately 600,000 people developed cancer and approximately 320,000 died of cancer during the year. The incidence of death from cancer of the stomach and uterus has been decreased since 1930 while deaths from lung cancer and leukemia have increased markedly (Fig. 28). The relationship between age and cancer is shown in Figures 29 and 30.

There is no diet that prevents cancer in man. However, individuals in good nutritional state are less likely to develop cancer. Cancer cells require the same type of nutrients as do normal body cells. They compete favorably for nutrients, particularly calories and nitrogen, with the tumor growing at the expense of normal tissues. Some cancer cells have greater nutrient needs than normal cells. For instance, leukemia cells in children require both more folic acid and more asparagine.

The major known causes of cancer are felt to be viruses and cancer-producing chemicals in food and the environment. The food we eat may contain preservatives and other purposefully introduced additives; chemicals may be altered by heating and other processes; or contamination by bacteria, mold, fungi, and other organisms may produce cancer-producing metabolites. Some cancer-producing chemicals occur naturally in food. For example, the alkaloid of chili peppers led to the development of liver cancers in rats. These chemicals are normally detoxified by the liver and may produce a carcinogenic effect at very low levels of concentration. The B vitamins, particularly riboflavin, have been shown to be essential for some of the detoxification processes and their presence in the diet, in adequate amounts, has been shown to protect against the development of liver cancer in rats.

For several years, a higher occurrence of cancer was thought to occur among persons who were overweight. Further evaluation of the data has shown that overweight women with diabetes do develop somewhat more cancer of the uterus and pancreas, but there is no general increase in cancer related to excess weight in men.

There is a small but growing body of data suggesting that chronic low-level intake of some nutrients is a factor in the incidence of cancer in man. There is evidence that vitamin deficiency plays a role in the occurrence of cancer of the oral cavity in the esophagus.

Chronic vitamin B complex deficiency, due to inadequate supply of vegetables in the diet, appears to be incriminated. There is recent evidence, March 1970, that dietary iodine deficiency may contribute to breast cancer, at least in rats. Demographic studies reveal that human breast cancer incidence is high in iodine-deficient areas.

Epidemiologic data suggest the possibility of a relationship between fat in the diet and cancer. A strong positive relationship has been shown between dietary fat intake and the death rate from breast cancer in various countries of the world. Also, an increased incidence in cancer was seen in men who ate a diet high in polyunsaturated fat as a substitution for saturated fat to protect against fatal atherosclerotic events. Refined carbohydrates also have been linked to an increase in cancer of the colon.

Data relating nutrition to the incidence and control of cancer are still too fragmentary and hypothetical to provide a basis for estimating benefits from diet management. The results of ongoing research may justify appreciable benefit claims from regulation of diet in the avoidance and management of cancer.

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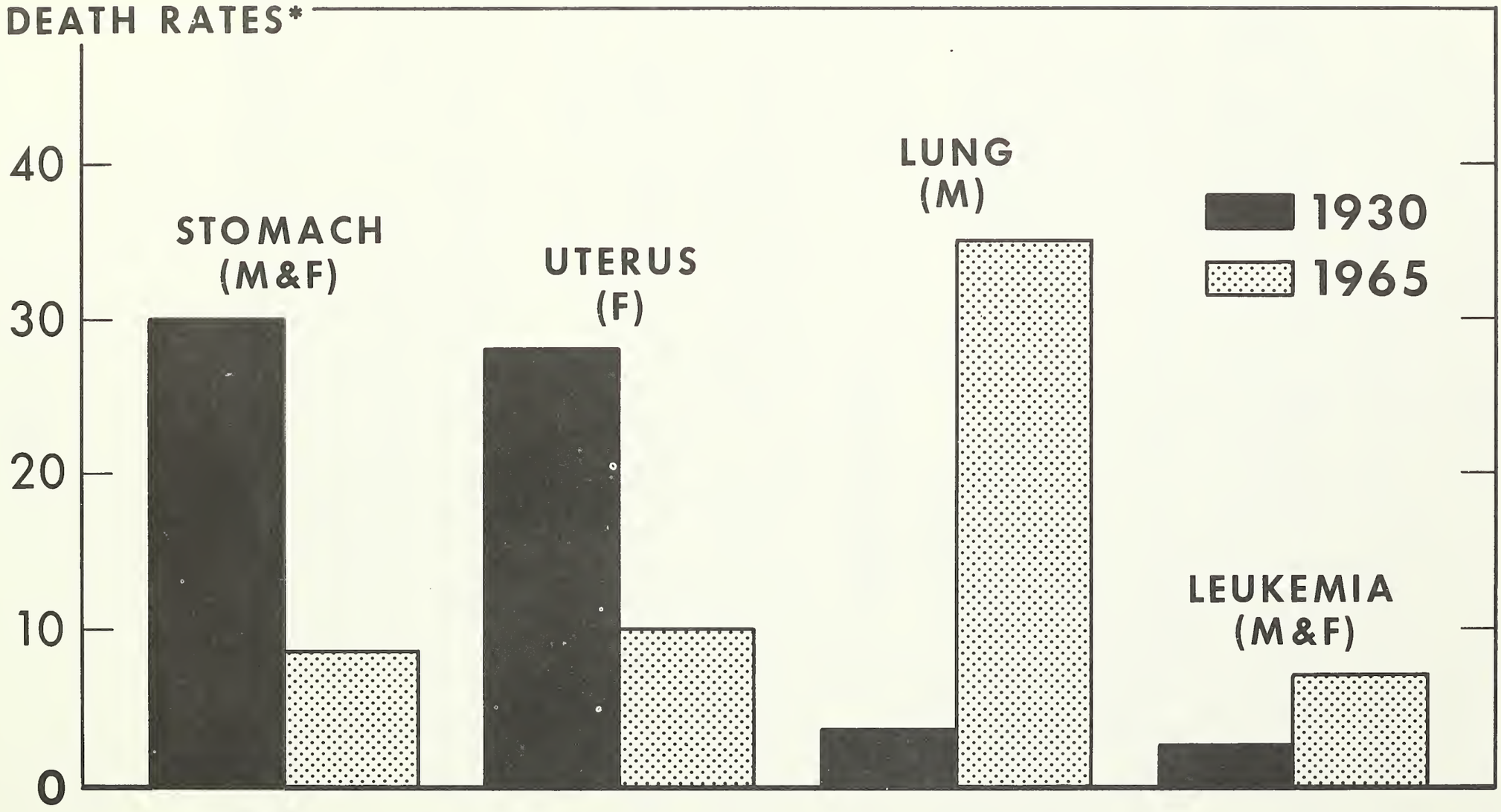
CANCER

U.S. Death Rate, 1930 and 1965



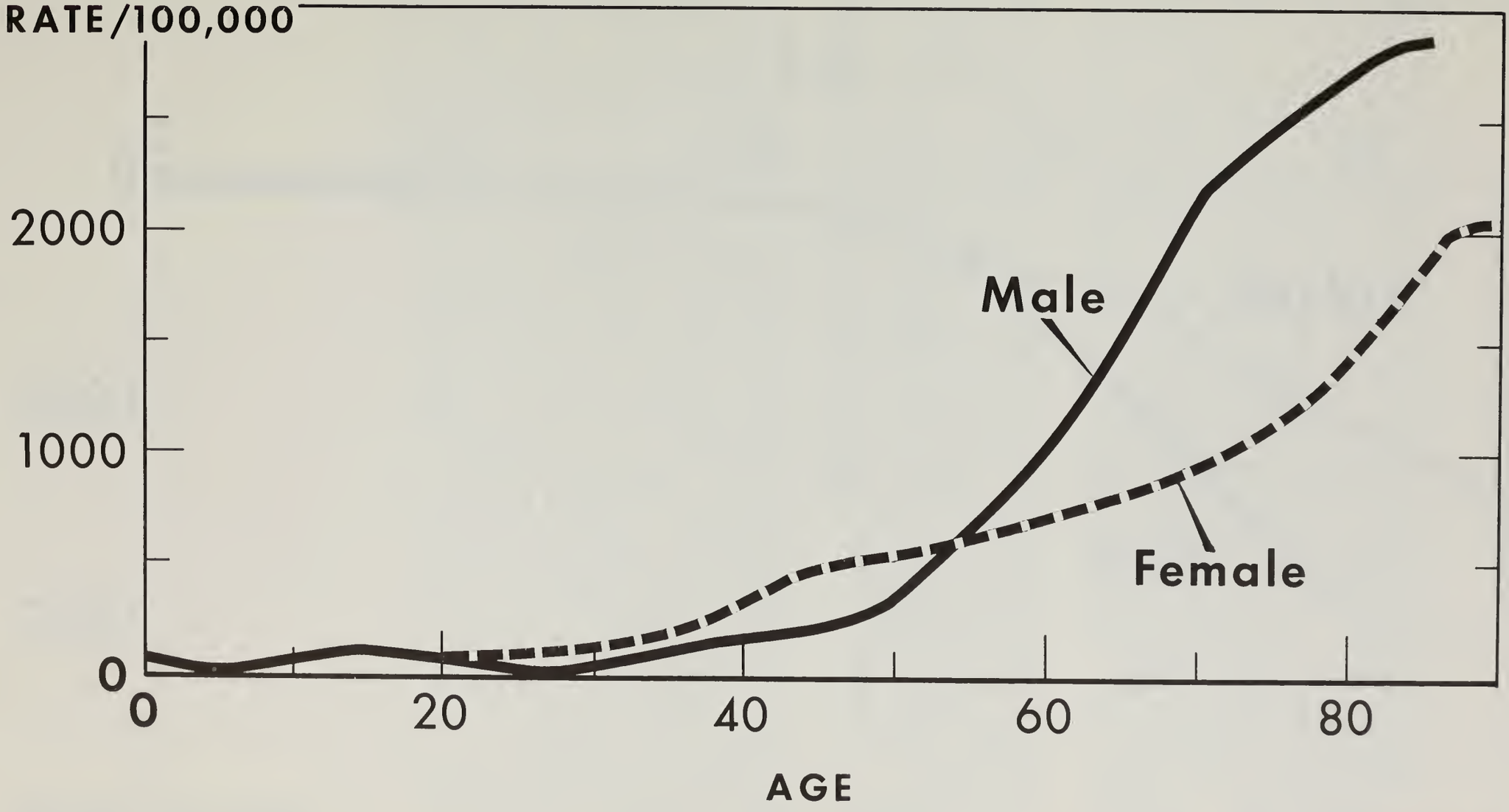
*AGE-ADJUSTED DEATH RATE PER 100,000 WHITE POPULATION

SOURCE: HEW

Figure 28

INCIDENCE OF CANCER

By Sex and Age, 1964

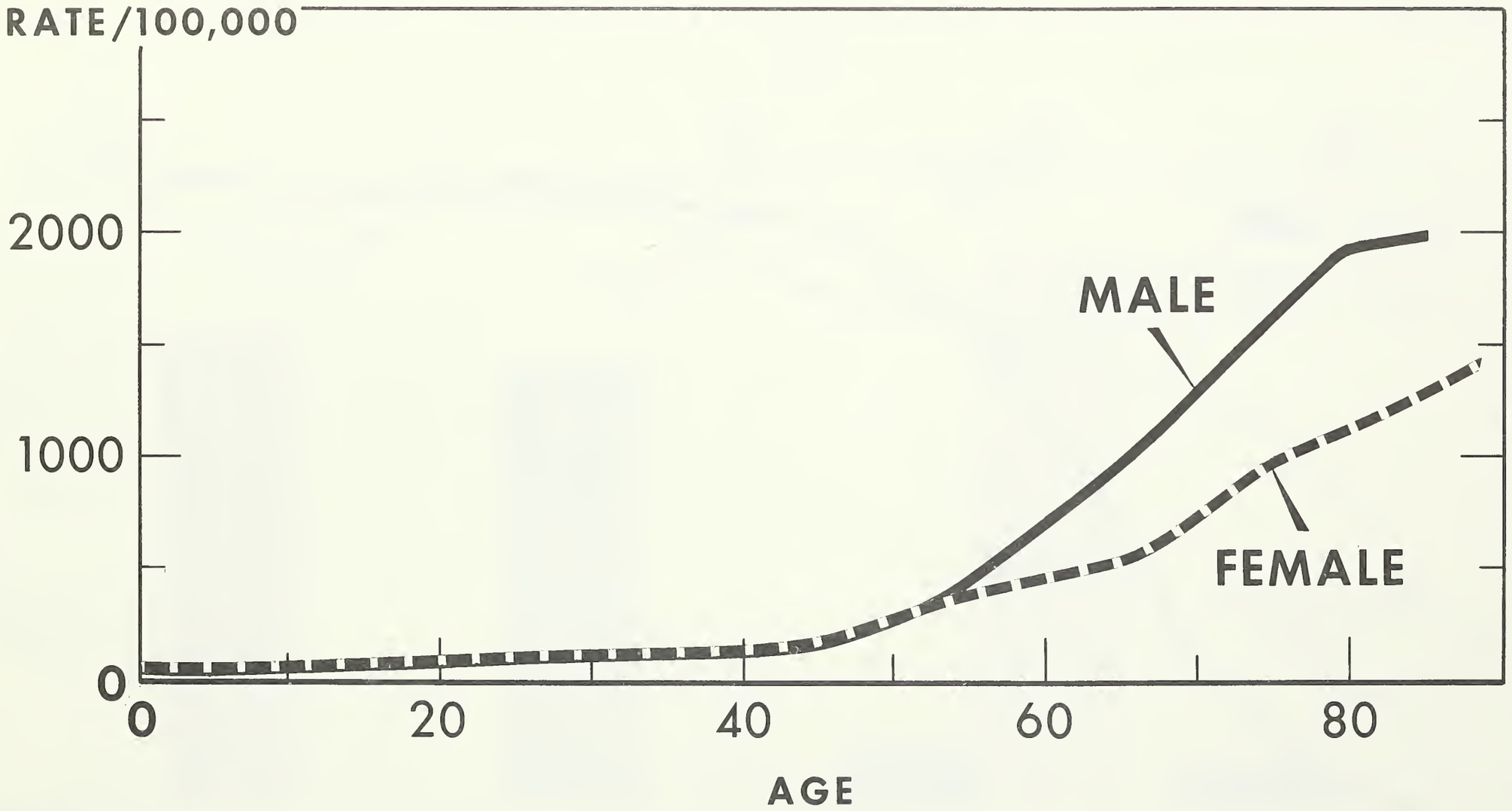


SOURCE: HEW

Figure 29

MORTALITY FROM CANCER

By Sex and Age , 1964



SOURCE: HEW

Figure 30

The close relationship between nutrition, growth rate, and final height has been recognized for years. The potential for future improvement in the U. S. appears to be very small except for those population groups where nutritional stress is great. The National Nutrition Survey of 1968-1969 has shown that for low income families, there is a larger number of children below the average height than expected. Growth retardation was seen in about 3.5 percent of the preschool age children but not in those over five years of age. Early growth retardation, as in the preschool children, is not reversed by improved diet at a later age. Height rather than weight is affected. The cause of the retardation was more likely a nutrient deficiency other than calorie-protein undernutrition. Both vitamins A and C status were below acceptable levels.

The most recent change in population trends has been the earlier age at which physical maturation is reached. Very little is known of the long range implications for man of rapid growth during infancy and childhood. Long-term studies with rats have shown that those which reached their adult weight early had a markedly reduced total lifespan. The findings have not yet been demonstrated in man. The earlier maturation age of children also has raised a number of yet unresolved social and educational problems.

Proper diet is needed to maintain, as well as to develop, each individual's potential for muscular and skeletal growth. Malnutrition as well as undernutrition decreases a worker's productivity. Apathy, lethargy, and lack of initiative results. Ability to learn new tasks may be reduced. Resistance to disease also is lowered, increasing the rate of absenteeism from the job. This aspect has been discussed in greater detail in RESPIRATORY AND INFECTIOUS DISEASES and DIGESTIVE DISEASES. Thus, in a number of ways, improved diet may increase working efficiency due to feeling better on the job and then lead to economic benefits. An 0.5 percent increase in on-the-job efficiency has been suggested as a possibility from improved nutrition. The benefit when expressed in terms of increased wage and salary disbursements over the 1968 total approximated 2.3 billion dollars. Research findings during the next ten years may permit 20 percent of the benefit to be realized.

Accident rates are high among those who tire quickly due to malnutrition. In the U. S., in 1967, accidents ranked fourth as a cause of death, accounting for over 113,000 deaths (Table 25). In addition, 51.8 million people were injured severely enough to restrict activity or require medical attention. These accounted for 324.5 million days of disability.

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TABLE 25

Incidence of and deaths from injuries and days lost from work and school: July 1965 to June 1966[1]

Incidence, in thousands	48,357
Deaths, total	113,169
Days lost from work per year in thousands	88,622
per 100 employed persons	121.2
Days lost from school per year in thousands	10,486
per 100 children	24.7

[1]Data are based on household interviews of the civilian, noninstitutional populations.

Source: National Center for Health Statistics 1967 PHS publ. 1000, series 10, no. 37. U. S. Dept. of Health, Education, and Welfare.

IMPROVED LEARNING ABILITY

Improved diet may improve learning ability in a number of ways, some of which have already been discussed (MENTAL HEALTH). Some specific nutritional deficiencies limit ability to learn, for example, by causing blindness (EYESIGHT) and by causing apathy and tiredness (ANEMIA AND OTHER DEFICIENCY DISEASES). Improper diet may also affect learning directly through its effect on brain and central nervous system development during the fetal period, infancy, and early childhood. Malnutrition in school age children and adults may handicap learning ability by shortening attention-span and decreasing the ability to work at the same task for any sustained period.

The President's Committee on Mental Retardation is studying the relationship between mental retardation and nutrition and plans to submit a report by June 1, 1970. The Committee has not been able to establish a causal relationship between nutrition and mental retardation because of the complexity of the problem and lack of basic data. They note, however, that among the poor, severe mental retardation is two or three times the average. They suggest that this greater incidence of mental retardation may be due to poor nutrition, prematurity, poor hygiene, or a combination of the three.

The incidence of mental retardation is high. Over a quarter of a million people were institutionalized in 1967 in the U. S. In addition, there are many thousands in jails and correctional institutions. About three to four percent of the total number of the persons classified as retarded are accounted for by the institutional figures. Over 6.5 million persons may be involved. Improved diet, based on research yet to be done, during the critical years of pregnancy, infancy, and childhood, has a good possibility of increasing the mental performance of about one-half the potential retardees. Benefits would be realized from the savings on institutional costs, improved possibilities for employment and reduced likelihood of civil offenses.

The consequences of malnutrition in terms of impairment of learning ability depends on the time in life when the deprivation occurs as well as its extent and duration. For the brain, the most critical period is the five months prior to birth and about ten months after birth. By the end of the second year, the brain has practically completed its growth. Studies on rats have shown that the brain grows both by increase in the number of cells and by increase in the

size of each cell. Severe malnutrition during the period of cell division permanently reduces the total number of cells and cannot be repaired by subsequent proper diet. Malnutrition during the cell growth phase is reparable by improved diet. Direct application to humans is not possible, because similar studies are not possible with human infants. However, the brains of infants who died of marasmus were found to have fewer brain cells than those of infants who died from accidents.

Interest in the role of nutrition in mental development and learning ability has been stimulated by problems in developing countries where lack of food and undernutrition have great economic significance. The implications for children from low income families in the U. S. are now being studied. The National Nutrition Survey found evidence of retarded physical growth in about 3.5 percent of children from low income families. It is possible that these children also may have lasting damage to mental capacity. Severe deficiency of individual nutrients and undernutrition in general have been shown to adversely affect development of the brain and central nervous system in animals. Studies in developing countries have suggested that findings with animals may be extended to severely undernourished children. There is little or no information concerning the effects of chronic low level nutrient deficiencies found in the U. S. upon permanent mental damage.

A number of studies are in progress on the effects of feeding programs for preschool and school age children upon their mental ability as indicated by I.Q. grades and learning ability. Preliminary results in a New Orleans, Louisiana, study using nonverbal performance tests have shown no differences between normal and anemic children of a very young age (4 years, 5 months to 4 years, 9 months). However, anemic children about a year older had slightly lower I.Q.'s than comparable normal children. Follow-up after a year of kindergarten showed that the anemic children receiving a multiple mineral and vitamin supplement had gained as much as ten I.Q. points more than the anemic children who didn't get the supplement. While there were no differences between the normal and anemic children on short-term attention tests, the performance in the anemic children deteriorated rapidly when the reaction time was longer, and they made more errors on rapid tests. Similar results were found in Philadelphia, Pennsylvania, where the I.Q.'s of anemic children, 4 and 5 years of age, were similar to those of nonanemic children, but their attentiveness was significantly less. Because attentiveness is essential to learning, the potential

for learning could be expected to increase when the diet was improved. This is an example of what might be accomplished for children by improving their diet. Conceivably, improved diets from prenatal to school age might increase the learning ability of 50 percent of children sufficiently to increase their I.Q. by ten points.

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IMPROVED EFFICIENCY IN FOOD SELECTION

Efficient food selection is essential to improved nutrition and better diets. It is possible for individuals to select nutritionally adequate diets from available foods if the necessary information and motivation is provided. The 1965 Household Food Consumption Survey indicated that 22 percent of the diets were below the recommended allowances in 1 nutrient, 13 percent in 2 nutrients, and 15 percent in 3 or more nutrients. Because the majority of households regardless of income level had adequate diets, it is reasonable to conclude that efficient food selection could result in all households having adequate diets.

The effectiveness of food selection in diet improvement is contingent on the availability of nutritious foods which people like to eat, in adequate amounts and at a cost which they can afford.

Fundamental to diet improvement through food selection is the ability to change food habits and to develop new diet patterns. Proper eating habits need to be established early in life. Many food likes and dislikes are set by 3 years of age. Food provides a variety of satisfactions besides its nutritional value, thus changes in food habits are not easy to make or maintain. Very little is known of the role of physiological and emotional factors in developing food habits and how they may be utilized in making and maintaining recommended dietary changes. Better knowledge of these relationships would assist in designing food combinations, selecting and developing foods which would be readily acceptable and make desirable dietary changes possible and easy.

Benefits from improved food selection are reflected in better overall general health and well-being and share in the benefits from the avoidance and modification of health problems. There also are personal satisfactions from the freedom to choose foods that are liked and do not require divergence from established food habits and social customs.

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IMPROVED EFFICIENCY IN FOOD PREPARATION AND MENU PLANNING

Economic and social changes coupled with advances in food technology have impelled changes in food preparation practices and menu planning. The result is less time and work spent in preparing food in homes and food service institutions and a wider variety of foods available for menu planning. Rising labor costs in food service institutions and employment of women outside the home have produced an increased demand for partially prepared and ready-to-eat foods.

Changes in the life style of families have affected both food preparation and menu planning. Fewer meals are eaten as a family group, snacks may provide as much as 20 percent of the day's caloric needs, and over one-third of all meals are eaten away from home. Mothers and homemakers are less likely to know what foods have been eaten by individual family members.

Traditionally, knowledge of food preparation and meal planning was handed down from mother to daughter in the home. This means of education is no longer satisfactory. Mothers employed outside the home do not have time for training their daughters, and the information available to them is inadequate. The foods available are increasing in variety and changing in type, so there is constant need to adapt preparation procedures. Processed and fabricated foods are often not comparable nutritionally to the foods they replace. Planning of adequate diets is becoming more complex as nutrition knowledge increases and foods become more refined. The responsibility for good diets now must be shared by all members of the family who eat meals away from home, by food service institutions which provide the meals, and by food processors. Ensuring adequate intakes of essential nutrients is not enough to assure good nutrition. Nutritional problems may also arise from improper selection of dietary fats and carbohydrates.

Better as well as more efficient methods of food preparation are needed if the nutritional value of diets is to be improved. Improved diets can be effective only if the foods recommended or served are eaten. Poorly prepared foods are unappetizing. The desirable eating qualities of some nutritionally important foods such as vegetables are easily lost by improper preparation and handling procedures. Consumption of vegetables, particularly green vegetables, has declined since 1955. The lack of satisfactory ways of ensuring retention of their color, flavor, and texture during preparation and serving may explain why vegetables are among the foods least liked by teenagers and young adults.

Besides improved health, benefits from improved efficiency in food preparation may be expressed in terms of time, labor and cost savings in preparing food in the home and in food service institutions. Mechanization and automation of some aspects of food preparation may be more economically carried out for a large quantity of food. By-products of food preparation which would be considered waste in the home or institution may be transformed to useful products when available in larger quantities in a commercial situation. For example, fat trimmed from meats, bones, outer leaves and peelings from vegetables may be converted to animal feeds or disposed of in a manner which would not add to the pollution, sewage, and garbage disposal systems of communities.

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REDUCED LOSSES OF NUTRIENTS IN FOOD STORAGE, HANDLING AND PREPARATION

Improved food preparation techniques would reduce the loss of some nutrients and increase the availability of others. As a result, the nutritional value of diets could be improved without modification of feeding patterns. The nutrients most likely to benefit are the water soluble vitamins, minerals, and amino acids. Water soluble vitamins and minerals leached into cooking water may be reclaimed. Up to 50 percent of the water soluble vitamins, thiamine, and ascorbic acid may be lost if the cooking water is not used. Even greater losses, up to 90 percent, occur when cooked foods are held for long periods of time or are reheated. One of these procedures and sometimes both are necessary in food service operations and at home when prepared foods are used.

Processors' attention is centered on palatability, not nutritive value, when prepared food products are designed and methods for reheating are recommended. New processing techniques coupled with improved methods of handling and preparing processed foods could ensure vitamin losses no greater than 25 percent. This would mean fewer persons with diets inadequate in vitamin C. Based on findings of the National Nutrition Survey 1968-69, 27 to 41 percent of households now on the poverty level and 20 to 40 percent of those above the poverty level have diets less than adequate in vitamin C. The number of households with inadequate diets may be reduced by one-fourth through use of improved food preparation and handling procedures.

Cooking food has been shown to reduce the availability of amino acids. In meats, as much as 60 percent of methionine and lysine may be made unavailable; in some cereal products, the amount may be higher. The decreased availability of amino acids is often associated with development of desirable flavor. The reduction in available amino acid content of food as a result of cooking is probably insignificant nutritionally in U.S. diets which are generally high in protein. Methionine and lysine are the amino acids likely to be affected and are also those most likely to be deficient in cereal based diets. Preparation procedures designed to minimize the binding of these amino acids would benefit population groups whose protein intake may be marginal for economic or ethical reasons, or individual preferences.

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IMPROVED EFFICIENCY IN FOOD PROGRAMS

Maximum improvement in diets and nutrition through food programs can be achieved only through coordinated planning by nutritionists, food technologists, economists, and educators. Coordinated subject planning by all of these disciplines is needed to ensure that food programs accomplish the goal of wiping out malnutrition in the shortest possible time and at a minimum cost.

Recent attention to malnutrition in the U.S. is focused on a number of vulnerable population groups. The nutrition of these individuals may be improved through education, economic assistance, or improving the nutritional value of available foods. Most existing Federal food programs are directed to families with low incomes, school age children, infants, and pregnant women. In 1970, approximately 1.6 billion dollars was spent for these programs; about 3.5 billion free and reduced price school lunches and 72 million free school breakfasts were served. Slightly more than 23 million children participated in school lunch programs, and over one-half million in the breakfast program. It was estimated that about 5 million of the 7.8 million needy children were reached.

Food consumption surveys show a direct relationship between income and dietary adequacy (Table 26). In a nationwide survey of Household Food Consumption in 1965, 63 percent of households with incomes less than $3,000 had diets below recommended daily allowances for one or more nutrients. This percentage can be compared with 37 percent of households with incomes over $10,000. Further, more nutrients were likely to be lacking in the diets of low income groups. Providing nutritionally adequate diets to all persons eligible for food programs would substantially reduce the size of the malnutrition problem. It is estimated that one-fifth of the U.S. diets, or 40,000,000 provide inadequate nutrients. Also, one-fifth to one-fourth of persons have low incomes. These are not always the same but at least half the poor diets occurred among low income persons. Thus, providing better food assistance programs might be expected to improve the health of 20 million people.

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TABLE 26

Relation of income to dietary adequacy

Income level	Percent of diets below allowances for 1 or more nutrients	Average number of nutrients below allowances
Under $3,000	63	2.5
$3,000-$4,999	57	2.2
$5,000-$6,999	47	2.2
$7,000-$9,999	44	2.0
$10,000 and over	37	1.9

Source: Consumer and Food Economics Research Division 1968 Dietary levels of households in the United States, spring 1965. A preliminary report. ARS 62-17, USDA, Washington, D. C.

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